ISSN 0317-2473

Research Discussion Paper No. 57

A CAUSAL MODELLING APPROACH OF ANALYZING STATISTICAL INTERACTION: ETHNIC DIFFERENTIALS IN THE TIMING OF EARLY FAMILY FORMATION IN SRI LANKA AND MALAYSIA

by

Wei-Jun Jean Yeung

Department of Sociology
University of Alberta
Edmonton, Alberta
T6G 2H4, Canada

April 1989

Abstract

This paper demonstrates the utility of LISREL (Linear Structural Relationship) analysis to estimate nonadditive relationships among variables. Statistical methods commonly used to examine research problems involving interaction effects in Sociological literature are briefly reviewed, and methodological problems noted. Through a substantive study of the cultural and structural determinants of the timing of early family formation in the major ethnic groups in Malaysia and Sri Lanka, we demonstrate how the LISREL multiple-sample analysis can be useful in specifying and estimating the joint effects of various independent variables. The strength and limitations of the LISREL multiple-sample analysis in comparison to the other commonly used methods for analyzing interaction effects are also discussed.

1. Introduction

Most social research attempts to move beyond description and aims at explaining or predicting the social phenomena of interest. In view of the complex nature of the subject matter under study in social sciences, it is unavoidable that two or more variables will usually be involved. Indeed, one of the basic difficulties encountered in social research is the existence of a large number of variables that are interrelated. The challenge to scientists is to use the principles of scientific methods to separate or evaluate the relative importance of diverse social forces. In experimental design, by careful manipulations the experimenter can isolate the separate effects of several independent variables operating simultaneously on a single dependent variable. Through randomization, the experimenter can also rule out certain possible disturbing influence that are unmeasured or unknown. In nonexperimental research, the task of isolating effects of various factors on the dependent variable often has to be accomplished with the aid of statistical control. It is clear that many social phenomena depend upon the joint effects of several variables. Furthermore, the effects of many social factors are conditional. That is to say, they depend upon the circumstances or conditions under which they occur as described by the "value" of other variables. Sociologists, however, have not always done a good job in representing and understanding this complexity.

In most sociological research, the relationships among variables are assumed to be additive. By "additivity", in the simplest sense, we mean that the effect of one variable on a second variable does not vary according to the values of a third variable. When the condition of additivity is not met, an interaction effect exists. Thus, when the effect of X_1 on Y depends on the level of X_2, the variables X_1 and X_2 are said to interact in the determination of Y. When interaction effects are present, the additive "main" effect and interaction effect must be disentangled. The main effect refers to the additive effect that a particular independent variable has on the dependent variable, considered independently of the other factor's main effect and the interaction effect. Both main effects and interaction effects have legitimate status in theory and may be necessary to complete model specification.

The infrequent use of nonadditive models is unfortunate since much of our reasoning in sociology implies interactions among variables. For example, we may hypothesize that the effect of schooling on earnings varies with an individual's length of labor market experience, or theorize that the effect of a person's IQ on his scholastic achievement varies with his or her parents' socioeconomic background. In these examples, a nonadditive relationship may well be implied between schooling and experience in determining earnings and between IQ and one's socioeconomic origin in determining scholastic achievement.

The scarcity of nonadditive models in published sociological analysis may be attributed to at least several factors. Firstly, of course, many range of relationships among variables in fact may be additive. Secondly, the parameters of additive equations usually can be estimated easily, directly and inexpensively with ordinary least squares regression. Thirdly, relatively few statistical techniques which are appropriate for analyzing interaction effects are well known to many researchers in this field. Fourthly, the concept of statistical interaction seems conceptually more difficult and poses greater challenges with respect to the process of theory building than do additive relationships. It demands a "second level" of reasoning in attempting to explain not just differences or variation in a particular dependent variable, but also the variation in relationships which some independent factors have on the dependent variable(s). Student of sociology may lack the necessary sophistication with both statistical analysis and theory construction necessary to model and estimate theories and hypothesis involving interaction. In studies where interaction effects are recognized and tested, analysis often follows one of several rather simplified approaches (e.g. adding cross-product term in regression equation, separate analysis for subgroups, or dummy variable regression or MCA).

This gap between the languages of theory and operation in social research has long been noted (Blalock, 1964). To bridge this gap, Blalock suggests that researchers emphasize integrating various verbal approaches to theory building with the construction of mathematical models consisting of simultaneous equations with causal interpretation (Blalock, 1969). The use of simultaneous equation models would seem especially appropriate when interaction is involved. In instances where interaction

is found, standard, simple language seems inadequately precise to describe the relationships involved. Simultaneous causal models are most useful in attempting to sort out the relative importance of each variable in a complex system, especially when multiple interaction effects exist.

This paper brings to the attention of researchers in sociology a causal framework that can be used to examine interaction effects among variables. LInear Structure RELationship (LISREL), a computer program developed by Joreskog, made available first in 1973, has the capacity of dealing with nonadditive research problems through multiple-sample analysis. This method is more frequently used in the psychometric literature (e.g. McGaw and Joreskog, 1971; Bloxom, 1972; Bechtoldt, 1974; Sorbom, 1974), but few applications of this method exist in sociological literature. The purpose of this paper is to demonstrate how the multiple-sample analysis can be used to examine nonadditive research problems.

This paper is organized as follows. Various methods of estimating interaction effects in sociological literature are first briefly reviewed with a discussion on their relative strength and drawbacks. The general framework of LISREL and the multiple-sample analysis are then presented. An empirical illustration of the LISREL multiple-sample analysis is used through a study on the cultural and structural determinants of the timing of early family formation for the major ethnic groups in Sri Lanka and Malaysia. Certain limitations and strength of the LISREL multiple-sample analysis are also discussed.

2. Common Practices in Sociological Literature

A survey of the articles which appeared in the American Sociological Review between 1981 and 1985 reveals that among the 257 articles, 64 made some attempt to analyze relationships involving interaction effects. Although interaction can be represented in various complicated forms of multiplicative models or nonlinear multiplicative models such as the relative excess model, conduciveness models, symmetric equilibrium models and so forth (Stolzenberg, 1974; Southwood, 1978), such complicated nonadditive models are seldom used in sociology. The survey of articles in

ASR shows that sociologists usually follow the relatively simple approaches presented below in modeling nonadditive relationships: separate analysis for subpopulaitons; addition of cross-product terms; or dummy variable regression.

2.1 Separate Analysis For Subpopulations

The most frequently used and convenient method in dealing with nonadditive relationship is to group the total study population, based on a variable which is suspected to interact with other variables, and to analyze the groups separately. Among the 64 articles in ASR 1981-85 that attempted to analyze interaction effects, this method is used in 28 of them (Bradshaw, 1985; Neidert and Farley, 1985; Hodson, 1984; Henretta, 1984; Oliver, 1984; Robinson, 1984; Smith, 1984; Peterson and Hagan, 1984; Spaeth, 1984; Coverman, 1983; Ransford and Miller, 1983; Rosenfeld, 1983; Treas, 1983; Morgan and Hirsosima, 1983; Jacobs, 1983; Logan and Collver, 1983; Tolbert II, 1982; Thornberry and Farnworth, 1982; DiMaggio, 1982; Wright et al., 1982; Baron and Bielby, 1982; Kercknoff et al., 1982; Choldin and Hanson, 1982; Mare, 1981; Kessler, 1981; McRoberts and Selbee, 1981; Thoit, 1981 Thornton, 1981).

This method has the "heuristic" advantage of making research problem easy to conceptualize, and results are easy to present. However, statistical tests of the differences between effects in subgroups are usually not performed when this method is used. Although post hoc statistical tests of difference in partial effects across different groups can be computed manually, only a small proportion of studies which use this method reported such tests. In the 28 articles in ASR cited above, only eight articles have statistical tests of the differences in effects across the subpopulations (Hodson, 1984; Henretta, 1984; Peterson and Hagan, 1984; Spaeth, 1984; Coverman, 1983; Ransford and Miller, 1983; Thornberry and Farnworth, 1982; Kessler, 1981). Another drawback with this approach is that analysis almost always has to model interaction very simply. The observation and calculation of post hoc tests for between-group difference become very complicated as the number of groups increases, and, of course, sub-sample size decreases.

2.2 Cross-product Term(s) In Regression or ANOVA Equation

Another common practice is adding cross-product term(s) to an additive regression model. This method is used in eighteen articles in ASR 1981-85 (Feinberg, 1985; Blake, 1985; Berk and Newton, 1985; Winship and Mare, 1984; Kessler and Mcleod, 1984; Erickson and Nosanchuk, 1984; Hout, 1984; Hicks, 1984; Rindfuss and Morgan, 1984; Mare and Winship, 1984; Wood and Hughes, 1984; Guterbock and London, 1983; Rose, et al., 1983; Seeman and Anderson, 1983; Liker, et al., 1983; Walters, 1983; Knoke, 1981; Logan and Schneider, 1981). This type of models take the form:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_1X_2 + e$$

This model is relatively easy to create and can be estimated using OLS regression.

The prevalence of the use of adding cross-product terms in regression equation may have its origin in Blalock's presentation of interaction effects in his textbook Social Statistics (1960: 256-63) with which most sociologists were taught. In that book, Blalock teaches people to multiply the terms, use all orders of interaction and test if the all cross-product terms contribute to any significant improvement in the explained variance of the dependent variable.

This approach allows one to distinguish between the main effects (b_1 and b_2) of each independent variable (X_1 and X_2) and interaction effect (b_3) (including higher order interactions if they are relevant). However, two major practical problems often arise with this modelling of interaction. These problems have to do with the identification and interpretation of the functional form of interaction. The cross-product term is usually very highly correlated with one or both of the main effect variables. Thus, serious problems of near multicollinearity often accompany attempts at statistical estimation. Under such circumstances, the standard errors of regression coefficients may become very large and estimates of these coefficients become quite unreliable. Blalock (1965) and Gordon (1968) have pointed out that a high correlation between two independent variables can pose problems for the substantive interpretation of regression coefficients. When the cross-product term is highly correlated with one of the interacting variables but not the other, the estimates may simply be

an artifact of the means and standard deviations of the interactive variables. In Gordon's (1968) terms, the usual nonadditive model with two individual variables and a cross-product term entails a combination of "differential repetitiveness" and "unequal redundancy" which can cause misleading interpretations of any comparisons of the relative importance of variables on the basis of partial regression coefficients. Also, this technique often begs the question of identification of the functional form of the interaction effect, since it assumes that the interaction variable is composed as a simiple product of the relevant variables.

Interpretation of the results generated by this method is often problematic. Since the functional form of interaction lacks a clear definition, confusion may occur in interpreting the results (Hayduk and Wonnacot, 1980), especially when higher order interaction is involved. Allison (1977) notes that the magnitude of the coefficients of the cross-product term depends on an arbitrary constant and the scales of the interacting variables, when one or more of the variables in the product term are measured on interval scales. Thus, attempting to substantively interpret or test hypotheses about the coefficients is a futile exercise. Apart from problems that are likely to occur in interpreting the cross-product terms, when the interaction term(s) are large relative to the "main effects", it may not be a simple matter of translating from the statistical model represented in this form to a theoretical conceptualization or interpretation.

Compared to this method, separate analysis for subpopulation discussed in 2.1 does have the advantage of avoiding problems of statistical estimation and identification and substantive problems arising from interpretation of the functional form of interaction.

2.3 Dummy Variable Regression and MCA

Aside from the two dominant methods of analyzing the interaction effects, dummy variable regression or its derivative, Multiple Classification Analysis (MCA) is used in seven articles (Galaskiewicz, 1984; Ragin et al., 1984; Berk, 1983; Kessler and McRae, 1981; Baldassare, 1981; Nelson, 1981; Stevens, 1981). In both methods, the distributions of two variables which are suspected

to interact are partitioned into *m* and *n* intervals respectively. *m.n* dummy variables are so defined that a dummy variable equals one for a given data case if that data case takes on values falling into a particular interval of one of the interacting variables and a particular interval of the other otherwise, the dummy variables are set equal to zero otherwise. The advantage of using dummy variable regression is that coefficients are easy to interpret and multiplication of binary codes also gives an interaction terms that is easy to understand (since all combinations of codes but 1*1 give 0). MCA has the advantage of conducting tests focus on differences from the grand mean rather than differences from some omitted category. In this case, coding is conducted so as to estimate "effect" coefficients for each category (or combination of categories). R^2 is the same in either case (dummy orefect coding). Both techniques produce a fairly large number of coefficients. The large number of coefficients which model the joint effects of the interacting variables on the dependent variable can obscure the results. Researchers may find themselves reverting to the notion of variance explained rather than the pattern of effects. Because of the large amount of information generated from these kinds of analysis, the results on interaction effects are difficult to present and are often not reported. It is suspected that the frequency of application of this approach is in fact higher than what we see in the literature.

2.4 Other Approaches

A few other approaches used in examining interaction effects were found in the ARS 1981-5. They are discriminant analysis (Crader and Wentworth, 1984), comparative analysis (Hope, 1981), log-linear analysis (Fossett and Swicegood, 1982; Cohen, et al., 1981) multiplicative models (Simkus, 1984). Discussion on these rarely used methods in sociological literature is beyond the scope of this paper.

3. Interaction with LISREL

Interaction effects can also be estimated with LISREL through multiple-sample analysis, which is the focus of this paper. This method analyzes various subgroups simultaneously and yet

provides separate estimates for each subgroup. Seven examples of this application are found in the literature search of the publications in ASR (Alwin and Thornton, 1984; Lincoln and Kalleberg, 1985; Howell and Frese, 1983; Mercy and Steelman, 1982; Gottfredson, 1981; Smith, 1981; Judd, et al., 1981). This method is known to relatively fewer researchers in sociology. A complete technical discussion of this methods is beyond the scope of this paper. A few recent introductions to LISREL are available in literature (Joreskog and Sorbom, 1984; Hayduk, 1984; Long, 1983; Bentler and Bonett, 1980; Joreskog, 1981). In the following section, the framework of LISREL analysis in general and the multiple-sample analysis specifically will be described to set the stage for an empirical demonstration of this method. The strength of LISREL analysis, in comparison to the three dominant methods used in sociological literature discussed in 2.1, 2.2 and 2.3 is also noted.

3.1 General Framework of LISREL

LISREL is a general computer program for estimating coefficients in a set of linear structure equations (often referred to as structural equation models). The LISREL models may incorporate both observed and unobserved (latent) variables and have the capacity to adjust for measurement error. A LISREL model consists of two parts: the structural equation model and the measurement model. The structural equation model specifies the causal relationships among the latent variables and is used to describe the causal effects and the amount of unexplained variance. The measurement model specifies how the latent variables or hypothetical constructs are measured in terms of the observed variables and is used to describe the measurement properties (validities and reliabilities) of the observed variables.

The estimates are for the specified models arrived by using the maximum likelihood method based on the assumption that the observed variables have a multinormal distribution. The basic purpose of the estimation procedure is to find the set of parameter values that will imply a covariance structure that best fits the observed covariance structure.

A chi-square goodness-of-fit test is performed whenever maximum likelihood estimates are computed. The fitting function of the maximum likelihood procedure has a chi-square distribution with the degrees of freedom determined by the number of given parameters present and the number of parameters to be estimated in the model. The size of the chi-square statistic provides a means of assessing the goodness-of-fit between the model and data. Contrary to the chi-squares often used in other circumstances, a smaller chi-square value in LISREL indicates a better fitting model. A significant (large) chi-square indicates that the model-implied covariance deviates significantly from the observed variance-covariance matrix. That is, the difference cannot be attributed to the sampling fluctuations alone. This suggests that the model is misspecified and hence should be rejected. On the other hand, a nonsignificant chi-square suggests that the proposed model fits the data reasonably well and the difference between the proposed model and the data can be attributed to (mere) sampling errors. Thus the model may be accepted.

It should be noted that the chi-square statistic is very sensitive to sample size. A large sample size is required to obtain reliable estimates. With large sample sizes, sampling variablity decreases and differences between two samples are likely to be smaller. Thus, with a large sample, even a relatively small difference tends to be detactable as being more than mere sampling fluctuations and hence significant. Chi-square statistics, therefore, is not to be used as the only indicator of the goodness-of-fit of a model. LISREL also provides residuals and the standard errors of the parameters to be used along with the chi-square tests to assess the model.

Another property of the chi-square distribution is that the difference between the chi-squares of two alternative models is also distributed as chi-square with degrees of freedom equal to the difference in degrees of freedom between the two alternative models. The implication is that the significance of change in fit from one model to another can also be tested with chi-square statistics. This chi-square difference test is very useful in helping researchers to evaluate the relative adequacy of alternative models and the significance of improvement of fit to data from one model to another.

3.2 Multiple-sample Analysis With LISREL

The multiple-sample analysis estimates the structural and measurement models for several subsamples simultaneously. Yet separate estimates for each sub-group are also provided. In a multiple-sample analysis, a researcher can specify some or all of the coefficients to be equal among the subgroups while leaving others to vary across the groups (Hayduk, 1984). When an equality constraint for any parameter is imposed, the groups are analyzed simultaneously holding that parameter constant across the groups. Through making use of the multiple-sample analysis, LISREL is capable of dealing with any degree of difference between groups: from the one extreme where every coefficient is equal, to the other extreme where every coefficient is different in the subpopulations.

The multiple-sample analysis can be used to test if certain variable(s) in the model behave differently across the groups. If parameters vary significantly across the subgroups, interactioin effects among the variables is implied. LISREL provides an overall chi-square value for the whole population and statistics that help researchers to assess the goodness-of-fit for each submodel. The fit of the model in a multiple-sample analysis is calculated as a weighted average of the fits obtained for each subgroup individually. The test for interaction can be performed by comparing the chi-squares for two alternative models, where in the first model the particular parameters of interest are specified to be equal across the submodels and in the second model the same parameters are specified to be different across the submodels. The difference between the chi-squares for these two models, also distributed as chi-square, can be used to test if the change from the first to the second model is statistically significant. A significant change indicates that the independent variables to which these parameters refer interact with the categorical variable used as a basis for subpopulations definition. By comparing different model specifications, the variables that operate differently across the groups can be identified. Although the chi-square statistics are tests for the fit of the model, the difference of chi-squares for two nested models allows one to examine whether specific parameters are significantly different in the submodels. In calculating the difference between the two chi-squares, the effect of sample size on chi-square statistics is cancelled out. Therefore, the test of significance of

interaction is not influenced by sample size.

LISREL can deal with two types of invariance between models: the invariance in structural model and that in measurement model. This paper focuses on the issue of invariance in structural models and assumes equality of the measurement model for the subpopulations (i.e. the measurement properties of the variables used are assumed to be equal in each subgroup).

3.3 Strength of the LISREL Multiple-sample Analysis

LISREL multiple-sample analysis has several advantages in comparison to the three commonly used methods discussed earlier. Firstly, this method avoids potential problems of identification and difficulties in the interpretation of the functional form of the interaction related to the approach of adding cross-product terms to the equation. The functional form of interaction is not specified in the structural equation model. Substantive interpretation of the results is more straightforward than in other methods except for the separate analysis for subgroups, since the emphasis in interpretation is on effect coefficients for each subpopulation. Secondly, statistical tests of interaction can be easily computed by taking the difference of the chi-squares for alternative models. The computation is much easier in comparison with that that required by separate regression analysis of subgroups. Theoretically, LISREL can handle as many groups as necessary, limited by subgroup sample sizes. The criteria of defining groups can be anything as long as the groups are mutually exclusive and each group constitutes an independent representative sample which meets the assumption of multinormality. Thirdly, the indirect effects and the total effects which are not readily available in other methods can be easily obtained in LISREL analysis. Fourthly, LISREL analysis provides statistical tests for the adequacy of the causal model as a whole which allows one to assess the plausibility of alternative theoretical frameworks. With other methods, the best one can do is to judge the relative predicting power of various sets of independent variables by comparing the R^2s in various equations. In addition, LISREL has the capacity of adjusting for the measurement errors of the observed variables. This is not directly available in most regression models. The issue of measurement

errors, however, will not be the focus of this paper.

4. Empirical Illustration

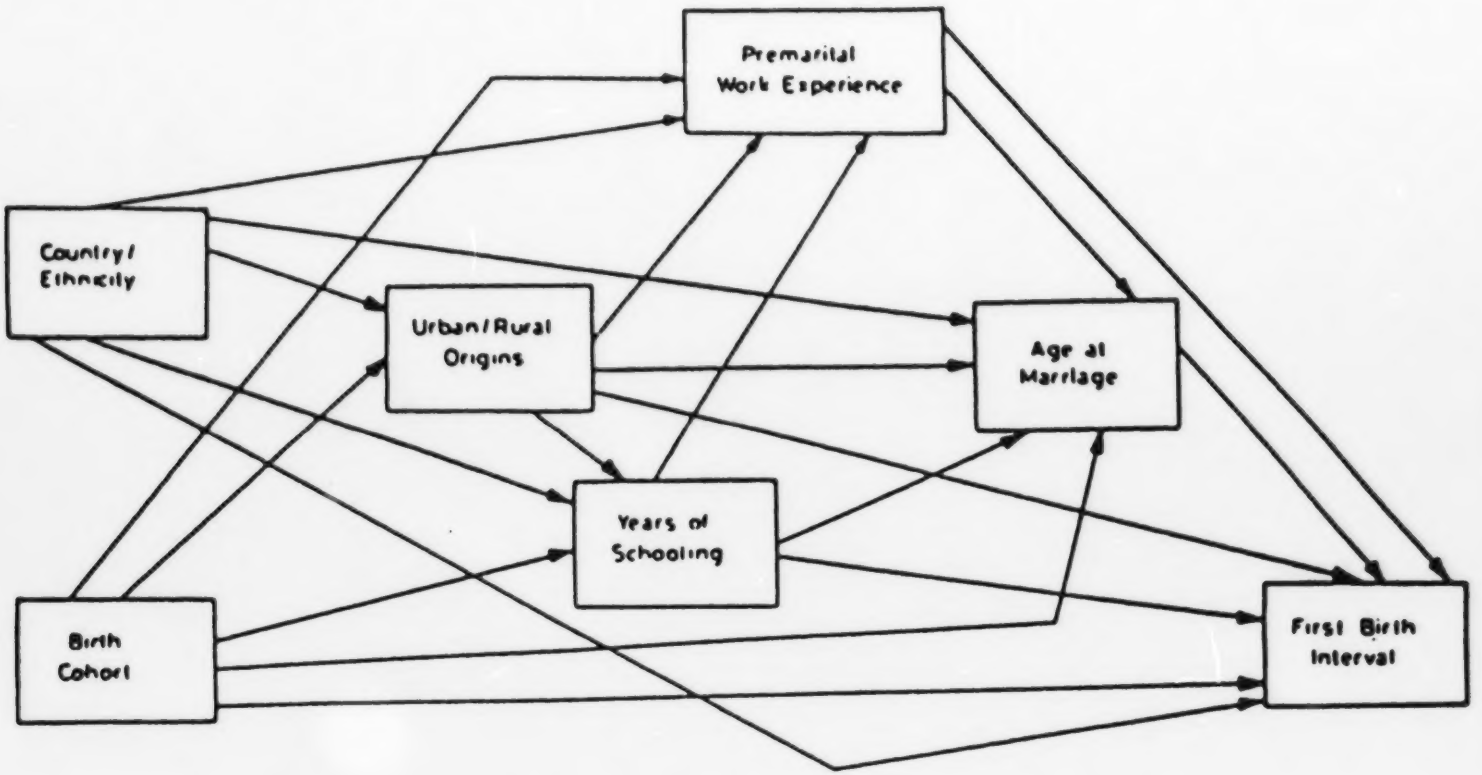
An empirical illustration of the multiple-sample analysis is made through an examination of the cultural and institutional determinants of the timing of early family formation in two less developed countries. The timing of early family formation is operationalized as (1) age at first marriage and (2) the interval between marriage and first birth. This illustration is built on Hirschman's (1985) study of social, cultural and economic determinants of the timing of family formation appeared in Demography. It is an extension of this paper with a different analytic strategy and a somewhat different focus.

Hirschman's study is an important effort to examine a central issue in linking development and fertility. Empirical results have shown that age at marriage and age at first birth have strong effects on the final fertility at both the individual and aggregate levels (Ryder, 1980). They not only affect subsequent fertility but also have broader implications for women's roles and social change in general. It therefore has an important implications for the population problems and socio-economic development in the Third World. Hirschman examines the general pattern of the timing of early family formation in five Asian countries. The present analysis focuses on cross-country and cross-ethnicity comparison of the determinants of early family formation in two of those countries. LISREL analysis is used to examine the subject matter in the hope of bridging the gap of the knowledge gained from Hirschman's initial investigation. In this section, Hirschman's study is summarized with a discussion on the methodological limitations in his study. A demonstration of the multiple-sample analysis then follow.

4.1 Hirschman's Study

Hirschman's study was an inquiry into the impact of premarital socioeconomic roles on the timing of early family formation. It also attempted to explain the variations in the pace of initial family formation observed across five Asian countries: Korea, Taiwan, Indonesia, Malaysia and Sri

Figure 1: Conceptual Framework For The Determinants Of The Early Family Formation In Hirschman's Study



Source: Reprinted from Hirschman (1985) "Premarital Socioeconomic Roles and The Timing Of Family Formation: A Comparative Study Of Five Asian Societies", Demography 22: 35-58.

Lanka. In his analysis, Hirschman created a large data set by merging data from five independent sample surveys. Multiple Classification Analysis was the statistical technique used in his study. A categorical variable called "country/ethnicity" was created to differentiate the 14 ethnic groups in the above-mentioned five countries defined by the criteria of nationality, ethnicity or mother tongue.

A conceptual framework was proposed to guide his analysis (Figure 1) with exogenous effects of country/ethnicity and birth cohort representing respondent's cultural background and the social changes that occurred over the years respectively. Several premarital socioeconomic characteristics were hypothesized to intervene between the effects of the exogenous variables and the timing of family formation: urban/rural origin, wife's education, wife's premarital work status and husband's occupation. [1] All variables were operationalized as categorical variables. Several multivariate additive models were estimated. The first model included ethnicity/country, urban/rural origin and the cohort effect as explanatory variables. In the subsequent three models, wife's education, wife's premarital employment and husband's occupation were added one at a time, in that order, to the equations. In the final model, age at marriage and all other variables were used to predict the timing of the first birth.

The analysis in Hirschman's study allowed him to draw some general conclusion. He reported that education was the most important determinant of age at first marriage. In general, women who held modern socioeconomic roles tended to marry later. Age at marriage played a critical intervening role in explaining differences in average age at first birth. A negative relationship between first birth interval and socioeconomic status was observed. Women with high education and premarital work experience had their first child sooner after the marriage than their counterparts. Although Hirschman notes that interaction effects between the institutional factors and ethnicity were common, results of nonadditive models were not reported in the paper.

[1] Hirschman's statistical analysis was not always consistent with this framework. Although his framework did not include husband's characteristic, husband's occupation was included in the analysis. Also two measures, age at first birth and first birth interval, were used to indicate timing of first child. Although only one of these two measures were represented in the diagram.

4.2 Methodological Limitations in Hirschman's Study

There are several methodological limitations in Hirschman's study. A basic assumption of MCA is that effects are additive. When interaction effects are present (as Hirschman notes), the basic assumption of MCA is violated. Secondly, merging data from five sample surveys may overlook methodological problems by ignoring differences among the five data sets which may result from different survey designs and varying degrees of systematic and nonsystematic errors in each survey. Since Hirschman's results from the aggregated data are in fact weighted averages of individual effects in each data set, results may mask the relationships among variables. Thirdly, the cross-country and cross-ethnicity comparisons are not fully explored.

5. An Examination with LISREL

This paper extends Hirschman's investigation in the following ways: (1) the analysis focuses on cross-country and cross-ethnicity comparisons, (2) the interaction effects between ethnicity and structural variables are examined, (3) indirect and total effects of the cultural and structural variables are discussed, and (4) measurement errors are adjusted for in the model. The LISREL multiple-sample analysis allows a direct examination of the manner in which socioeconomic determinants operate in each ethnic group, thereby testing the interaction between country/ethnicity and socioeconomic variables as they influence the timing of early family formation. With this method, interaction effects can be examined without merging the individual data sets.

The theoretical background and study population will follow Hirschman's study to a great extent, but limitations of data availability mean that only two countries, Sri Lanka and Malaysia, are examined in the present investigation.

5.1 Theoretical Background

The interest in the determinants of the timing of early family formation comes from theliterature on the triggering factors for the demographic transition. Two broad ideal types of fertility declines in the process of demographic transition can generally be identified. The first type

refers primarily to the restriction or postponement of fertility in the middle or later years of childbearing period. This typifies the shift from "natural" to controlled fertility after modern contraceptives become widely used and portray the pattern of demographic transition experienced by most European countries. Age at marriage has historically been relatively high in European societies (Dixon, 1971, Knoel, 1977) and fertility decline was mainly due to fertility restrictions in middle or later stages of family formation.

The second type of fertility decline was mainly due to a postponement of family formation in the early stages of the reproductive career through postponement of marriage and the first birth. This is the fertility decline pattern observed in many less developed countries. In these areas, early and universal marriage is a common practice and has been an important factor in high fertility. Research has shown that much of the changes in the less developed countries has been due to a rise in the age at marriage and a consequent lowering of fertility in the young age categories (Chander, 1977; WFS Report, Sri Lanka, 1978). Many countries in these areas have experienced a significant period of declines in fertility with only modest reductions in marital fertility (Cho and Retherford, 1974; Mauldin, 1981). Since contraception is rarely used before marriage or even before the first child is born, family planning programs are likely to be a less important influence on fertility decline. Davis (1963) points to the crucial importance of marital postponement as part of a "multiphasic response" toward lowering fertility in a number of these countries. An overall marriage reduction, in terms of higher age at marriage and lower proportions married at different age had characterized the early demographic transition of many developing countries (Cho and Retherford, 1974; Coale, 1974; Smith, 1976). This very different pattern of early family formation in most third world countries has prompted researchers to examine the determinants of age at marriage and first birth in the hope of gaining further understanding of the demographic transition in less developed areas.

Marriage patterns are influenced by a variety of institutional factors both at the societal and familial level (Dixon, 1971; Bumpass, 1969). Dixon (1971) points out three factors: (1) availability of mates measured by the sex ratio of men and women in the marriage market; (2) the feasibility of

marriage determined primarily by expectations regarding the financial and residential independence of the newly married couple and by the availability of resources to meet these obligations and; (3) the desirability of marriage, determined by the availability of institutional alternatives to marriage and childbearing and by the extent to which these alternatives are considered rewarding. Bumpass (1969) emphasizes the predominant importance for women of non-familial role as viable alternatives to marriage. Tien (1970) attributes rise of age at marriage to the societal control of individuals in the Chinese society. Smith (1976) postulates that future marriage behavior in Asia should reflect the paths of three key modernization process: urbanization, education and development and expansion of nonagricultural employment.

Of special interest to some social demographers are the divergent patterns of family formation that are observed in various ethnic groups. For example, in many Asian countries Muslims have an earlier age at marriage than other cultural groups. To explain the variation among these ethnic groups, a broad range of factors are relevant. Limited by the availability of data, the present analysis is restricted only to certain structural determinants at the individual level. Two major hypotheses of interpreting the differentials observed among the ethnic groups guide the analysis in this paper. The first hypothesis views the trend toward later family formation as part of a general process of economic development and societal transformation, particularly as it affects the role of young women. As the process of urbanization advances and women become better educated and participate in non-familial work, early marriage become undesirable, and an increase in age at marriage follows. To the degree that variation across ethnic groups reflects only socioeconomic differentials among the subpopulations. According to this hypothesis, characteristics intrinsic to the ethnic groups do not have direct effect on the timing of early family formation. In the course of time, if the socioeconomic differences disappear, so too will differences in early family formation. Therefore, statistically, controlling for the characteristics differences should eliminate any observed differences among ethnic groups.

The second hypothesis maintains that the cognitive beliefs, historical experience and other aspects of society shared by a particular cultural group affect the timing of family formation independently of structural changes. Much research has shown that most societies have strong norms about the appropriate ages for marriage, and that the norms for age at marriage are usually integrated with those of childbearing. This is also characteristic of ethnic groups. In places where social norms favor high fertility, the ideal age at marriage tends to be very young (Ebanks, 1986; Modell, 1979; Mitchell, 1971; Dixon, 1971). For example, the practice of dowry or bride price in some cultural groups might have an independent effect on the nuptiality patterns. This hypothesis views the subcultural nuptiality and fertility norms as the predominant determinant of the variation in the timing of early family formation. The main effects of ethnicity are significant after controlling for the characteristics differences. However, the impact of the subcultural norms may vary according to socioeconomic characteristics of the group. In other words, the subcultural norms may interact with the structural variables in determining when one gets married and has a first child. For example, the impact of education and female employment outside of home on the timing of early family formation may not be as strong for the Muslim communities where the group norms favor early marriage and high fertility as they are for the Buddist communities where nuptiality and fertility norms are not as clearly defined.

5.2 Data and Study Population

Data for both Sri Lanka and Malaysia are from the World Fertility Surveys (WFS). The survey for Malaysia was conducted in 1974 and restricted to Peninsular Malaysia (about 85% of the total population in Malaysia in 1970). The survey for Sri Lanka was done in 1975 and was based on a probability sample of the total population.

The samples in WFS surveys exclude women who were not married at the time of the survey. As pointed out by Hirschman, this introduces a systematic bias in the data by underestimating the mean age at first marriage. Given the incomplete family formation experience of young women, the analysis is also restricted to cohorts of women who have mostly completed their early family

formation. This includes those who were aged 30 or above and had experienced one or more live births at the time of the interview. Childless women, premarital births and child marriages are also excluded from the analysis [2]. The definition of the study population is identical to that used in Hirschman's study. This yields a study population with a sample size of 3746 and 3662 in Sri Lanka and Malaysia respectively.

5.3 Socioeconomic and Cultural Background in Malaysia and Sri Lanka

A brief review of the socioeconomic characteristics of our study population may help us to set up hypotheses and interpret the data. Both Sri Lanka and Malaysia are pluralistic societies. A comparison of the ethnic composition between the total population and the study population for the two countries is presented in Table 1. According to 1970 Census, Malay, Chinese, and Indians accounted for 53%, 36% and 11% of the total population in Malaysia respectively. Within Sri Lanka, the Sinhalese, Tamils and Moors are the major ethnic groups and constituted 72.0%, 20.5% and 6.5% of the total population respectively at the 1970 Census. In both countries, ethnicity and religion are very closely linked (Chander et al., 1977: 80; Abhayaratne and Jayewardene, 1967). The Malays belong to the orthodox Muslims of the Shafi'ite school. The Chinese are mainly Buddists with a small number of Christians and the majority of the Indians are Hindus. The Sinhalese are predominantly Buddists, the Tamils predominantly Hindus and the Moors exclusively Muslims. Ethnicity, reinforced by religion, makes for distinctive subcultural groups within the respective nations. Since ethnicity and religion are highly correlated (and therefore highly collinear), subsequent analysis is restricted to ethnicity. These groups are identifiable sub-cultures. Each group possess a distinct history and identity and members tend to congregate in particular regions (Chander, 1977; Abhayaratne and

[2]It was noted in previous research that 90 percent or more of the women who will ever marry have a live birth have done so by age 30 (Rindfuss et al., 1983, pp.258-269) and very few ever-married women have not had at least one live birth by the age of 30. It is likely that most of this childlessness is involuntary. Under such circumstances, it is not likely that the exclusion of childless women will biase the relationships we are examining. Postmaritally conceived births are excluded to avoid violating the assumption of the temporal order of these life course events which guide the organization of the basic conceptual model in this paper. Child marriages are also excluded from our analysis to avoid the potential biase resulted from the prolonged interval between age at marriage and the initiation of a family in marriages of such nature.

Table 1: Ethnic Composition of Respondents in Sri Lanka and Malaysia.

Country/Ethnicity	Percent Composition Within Each Country at 1970-1 Census	%(Number) In Study Population
Sri Lanka		
Total	100.0 (12,711,143)	100.0 (3746)
Sinhaleses	72.0	65.7 (2460)
Tamils	20.5	25.5 (955)
Sri Lanka Moor	6.5	8.0 (229)
Other	1.0	0.9 (32)
Peninsular Malaysia		
Total	100.0 (8,809,557)	100.0 (3662)
Malay	53.0	55.2 (2020)
Chinese	35.6	35.1 (1284)
Indian	10.6	9.2 (336)
Other	.8	.6 (22)

University of Alberta

Table 2: Selected Socioeconomic and Demographic Characteristics For Malaysia and Sri Lanka.

Characteristics	Malaysia	Sri Lanka
Percentage urban		
1960	25.2	17.9
1970	27.0	21.9
Adult Literacy Rate		
1960	53.0	75.0
1970	55.0	77.6
Percentage of Labor Force in Agriculture		
1960	63.1	56.3
1970	53.5	55.1
GNP per capita (US$, 1977)	$970	$160
Crude birth rate		
1960	39.1	30.0
1970	32.6	26.0
Infant death rate		
1960	75.0(1957)	63.0(1962)
1970	40.8	51.0

Source: World Population Data Sheet, 1979, World Bank, 1980. World Tables, 2nd edition.

University of Alberta

Table 3: Selected Socioeconomic Characteristics in Sri Lanka and Malaysia By Ethnicity (percentage distribution)

Characteristics	Sri Lanka				Malaysia			
	Total	Sinhalese	Tamils	S. L. Moors	Total	Malay	Chinese	Indian
Origin								
Urban	20.4	17.1	21.4	37.8	26.1	12.6	44.2	34.5
Rural	79.4	82.9	78.6	62.2	73.9	87.3	55.8	65.5
Respondent's Education								
No schooling	25.6	21.6	29.7	47.2	48.5	55.6	41.0	36.0
1-5 yrs	39.4	40.0	37.6	40.5	33.3	32.4	34.5	35.7
6-9 yrs	22.8	24.8	20.8	10.0	13.9	10.2	18.1	20.2
10-11 yrs	8.3	8.9	8.8	1.7	2.9	1.2	4.7	5.4
university and above	3.9	4.6	3.1	.7	1.4	.5	1.7	2.7
Respondent's Premarital Occupation								
Not Employed	69.7	68.2	67.0	90.3	51.0	57.2	39.4	60.1
Agricultural	15.3	12.9	25.9	3.0	31.0	34.2	26.5	30.4
Skilled/unskilled	8.1	10.7	2.5	4.3	8.1	3.8	16.8	.9
Sales/Service	1.34	1.7	.8	.3	5.1	2.1	10.6	1.8
Prof./Clerical	5.5	6.5	3.8	2.0	4.8	2.8	6.7	6.8
Partner's Education								
No schooling	8.9	7.8	10.7	13.9	18.4	24.1	10.2	14.9
1-5 yrs	42.0	41.2	43.1	48.7	41.6	41.5	43.0	38.7
6-9 yrs	32.6	35.5	26.2	27.9	29.9	28.4	32.2	29.2
10-11 yrs	10.0	9.2	12.6	7.7	5.8	2.8	9.2	9.2
university and above	6.5	6.3	7.4	1.8	4.7	1.6	3.9	6.8
Partner's Occupation								
Not Employed	.7	.4	.5	1.0	5.0	4.1	4.8	12.2
Agricultural	40.2	39.3	47.2	31.8	38.4	52.9	17.8	31.0
Skilled/unskilled	29.3	31.9	22.9	27.1	27.2	19.9	39.4	25.9
Sales/Service	16.2	15.7	13.0	30.4	17.9	14.4	25.2	11.9
Prof./Clerical	13.5	12.6	16.5	9.7	11.5	8.8	12.9	19.0

Jayewardene, 1967). This enables them to create institutions and associations which both reflect their culture and help perpetuate it. In Petersen's sense, these groups constitute subnations having putative biological descent, common territory and relative hostility to outsiders (Petersen, 1971: 216).

Both Sri Lanka and Malaysia have experienced fairly rapid economic growth and profound social and demographic changes in the past few decades. Table 2 summarizes some basic socioeconomic characteristics for the two countries at about the time of the surveys (1974). In general, Malaysia is more urban and has a higher GNP per capita, but Sri Lanka has a higher educational level. This general pattern is also seen in our study population. (Table 3). A greater proportion of women in Malaysia are employed before the first marriage.

Rather wide socioeconomic differences among the ethnic communities are observed. Within Sri Lanka, Moors are most urban, and yet they have the greatest proportion of people without any formal education. Sinhaleses have the highest educational attainment relative to the other two groups. There is great variation in the percentage of women who have had premarital working experience among the groups. Most Moor women (90%) have never worked before marriage. More Sinhalese women are employed and this employment is more likely to be in modern sectors. In terms of spouses' occupation, Sinhalese and Moors have relatively more people in the modern sectors. Tamils, immigrants of relatively recent times, are concentrated on tea and rubber plantations.

Within Malaysia, the Chinese are most modern in many respects. They are most urban and have a greatest proportion of women employed before marriage. The occupational structure of the Chinese is also more diversified. Half of the Chinese women have their spouses employed in the modern sectors. In contrast, the Malays have the most traditional characteristics. Most of the women have either never worked or are employed in agricultural sectors. The small but diverse Malaysian Indian community is intermediate on most socioeconomic characteristics and has a larger minority engaged as wage labourers on agricultural plantation. However, it should be noted that this group has the highest educational levels.

Table 4 : Mean Age At First Marriage and At First Birth, First Birth Interval in Sri Lanka And Malaysia by Ethnicity

Country/Ethnicity	Sample Size	Mean Age At First Marriage	Mean First Birth Interval (in months)
Sri Lanka			
Total	3746	18.9	24.1
Sinhaleses	2460	19.5	22.2
Tamils	955	17.6	28.6
Moors	299	16.5	26.4
Peninsular Malaysia			
Total	3662	18.0	26.4
Malay	2020	16.4	31.0
Chinese	1284	20.7	19.4
Indian	336	17.5	25.0

Note: Statistics for other ethnic groups are included in calculation but not presented in the table.

University of Alberta

As shown in Table 4, Sri Lanka has a slightly higher overall age at marriage than Malaysia. A fair amount of internal diversity is seen among the ethnic groups. Among the six ethnic groups, Sinhaleses and Chinese (predominantly Buddists) have the highest age at marriage, whereas Moors and Malays (predominantly Muslims) marry the earliest. Tamils and Malaysian Indians (predominantly Hindus) fall in the intermediate range. A relatively strong inverse relationship exists between the mean age at marriage and the first birth interval.

There appears to be a general pattern among the ethnic groups in these two countries. The Buddists have the most modern characteristics and latest age at marriage. Muslims are at the other extreme and the Hindus are intermediate (although the difference between Muslims and Hindus is not as clearcut). In terms of norms and customs relevant to the nuptiality and fertility patterns in these subgroups, Muslim values prescribe early marriage and childbearing while no clear nuptiality and fertility norms are prescribed in Buddism. Hindu values are closer to those of Muslims.

In Sri Lanka, the Sinhalese and Tamils (even more) are quite meticulous in working out dowry arrangement details. In the process, marriage is likely to be postponed because of the difficulty of raising the dowry (Duza and Baldwin, 1977). Also, the caste systems greatly restrict the legitimate marriage partners for the Hindus (Tamils) under the concept of maintaining the ritual purity of each caste group. The fact that Tamils are relatively recent immigrants may create an even greater difficulty in finding suitable marriage partners. Marriage is often not an independent affair of the young boy and girl, but an affair of the entire kin groups of both sides. They see marriage as a means to strengthen their relations or to create new relations through matrimonial alliances. The dowry system is absent among Moors and it is the groom who pays *mehr* to the bride and the grooms who undertakes the major part of other marriage expenses. This may contribute to an early age at marriage in this group.

It has been noted that in Malaysia, marital decision making is not nearly as elaborate or complex as it is in Sri Lanka (Duza and Baldwin, 1977). Even for the Malaysian Indians, the caste system is less important in its original functions of determining marriage prospects although the

residential caste rankings are still found. For Malays, arranged marriage remains the norms (Swift, 1964) and there is an absence of such constraints as caste, horoscope and dowry for this group. These factors may partly explain the lower age at marriage for the Malays. The Malaysian Chinese are relatively free from religious or moral constraints of nuptiality and fertility behavior. No pervasive subcultural norms and customs which favor early marriage and high fertility are discernible. In fact, for this relatively recent immigrant group, we may expect that the desirability of early marriage be greatly reduced as they strive to sustain their success in Malaysia.

5.4 Hypotheses

Based on the socioeconomic and cultural values described above, we may expect that the subcultural norms have an independent effect on the timing of early family formation. It is also expected that they may interact with structural changes reflected in the level of urbanization, educational attainment and female labor force participation in determining the observed differences in nuptiality and fertility behavior among the ethnic groups. Due to the stronger subgroup norms which are pertinent to the nuptiality and fertility behavior for the Hindus and Muslims, it is expected that the structural variables may have a relatively smaller effect for these groups than they do for the Sinhalese and the Chinese. Between the two Buddist communities, since the Malaysian Chinese are relatively free from cultural bounds of nuptiality behavior the impact of the structural changes may be stronger for them than for the Sinhalese.

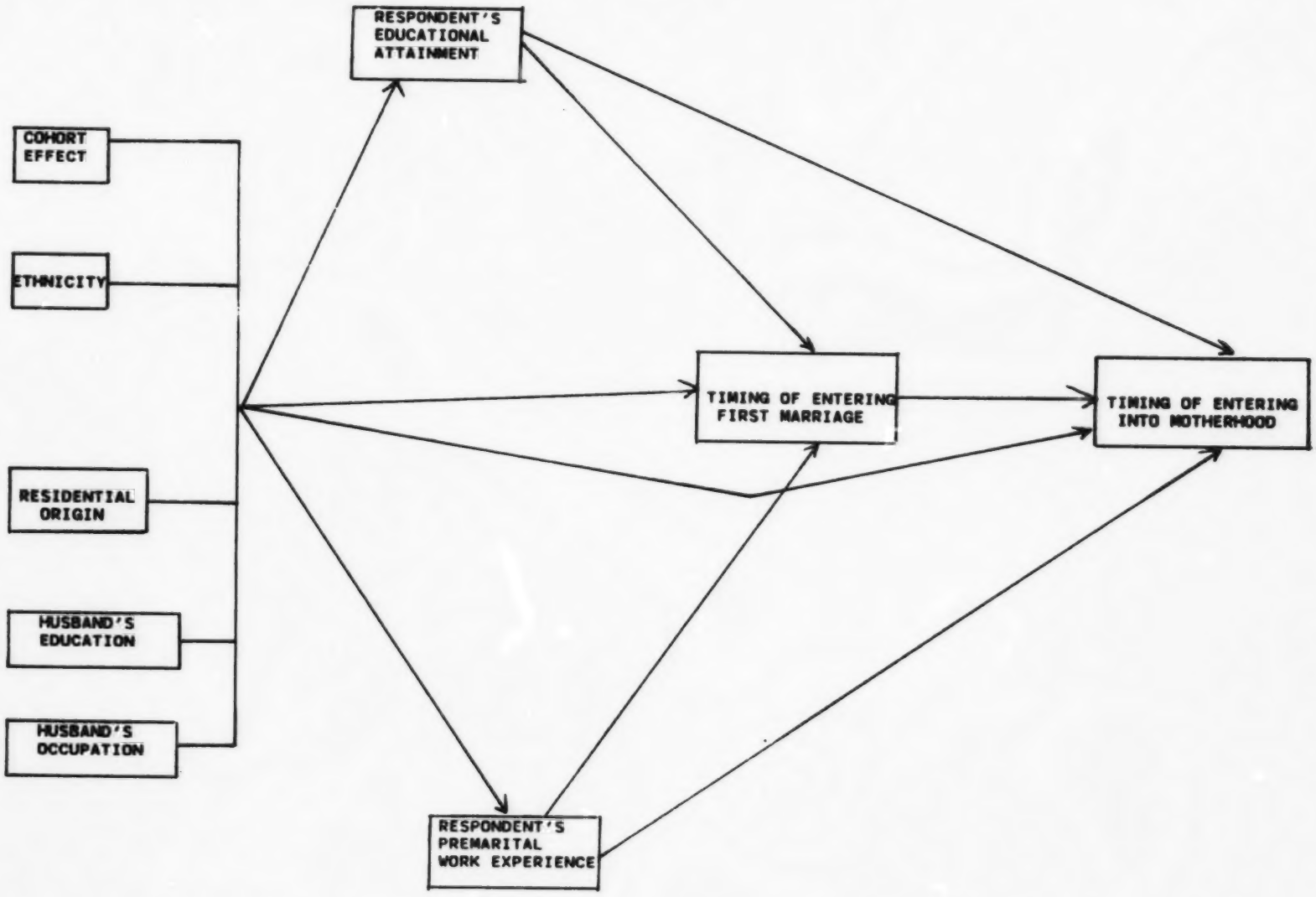
The structural variables may also have a different effect across the countries due to the different government policies which may directly or indirectly influence the timing of family formation. Such policies may include marriage laws, family planning programs, economic incentives or disincentives to early marriage and childbearing. For example, the special emphasis that the Sri Lankan government puts on women's education may create a stronger impact of education on nuptiality and fertility patterns than it is in Malaysia. Also, the effort of various Malaysian governmental development of urban-based cottage industries in textile or specialized areas such as electronics which integrate large number of women who do not necessarily have a formal education

may create a distinct impact of female employment in Malysia.

5.5 General Conceptual Framework

Figure 2 presents the general conceptual framework used in this paper. It is very similar to the original model in Hirschman's study (1985). However, in our analysis, only one measure for the timing of having a first child, the interval between marriage and first birth, is used. Age at first birth is not included in the analysis because it is very highly correlated (r=.93) and therefore collinear with age at marriage. Age, urban/rural origin and ethnicity are treated as exogenous variables. Husband's characteristics are also treated as exogenous factors. Husband's education is added to the model since several studies have pointed out that husband's education has a significant impact on nuptiality and fertility patterns in the developing countries (United Nations, 1983; Cochrane, 1979). Women with rural background are likely to begin childbearing earlier, both directly as a result of the higher fertility norms of agricultural communities and indirectly because women from agricultural families are less likely to engage in employment that conflict with early fertility. All the exogenous variables have direct and indirect effects through wife's education and premarital employment status on age at marriage and the first birth interval. Insofar as education is likely to impart values, aspirations and skills which encourage and facilitate non-familial roles, part of the effect of education on the timing of early family formation may be indirect through early work roles. Women who work outside the household, especially in wage employment, may be more likely to postpone marriage and childbearing after marriage. Clearly, for some women, the decision to enroll in school or to work is made simultaneously with choices about marriage (Hofferth and Moore, 1979; Marini, 1978; Voss, 1975). The issue of reciprocal causation is not examined in this paper. Several studies examining the reciprocal relationship between education and fertility have reported that the principal direction of causality is from education to age at first marriage and the first birth (Marini, 1978; Alexander and Ecklad, 1978; Rindfuss and Bumpuss, 1980). Age at marriage is a predictor of the first birth interval and mediates the effect of all culture-structural variables on the first birth interval.

Figure 2: Analytic Framework For The Socioeconomic Determinants of Early Family Formation.



5.6 Operationalization of the Framework

Table 5 describes both the unobserved (latent) variables and the observed variables (indicators) used in the LISREL model. Direct measures of subcultural norms are not available and ethnicity is used as a crude indicator. Ethnicity identity is also often treated as an indicator of social class (educational attainment, occupational distribution, and income level), degree of urban concentration and rural experience and social mobility patterns. The effect of ethnicity independent of these variables is taken as an approximation of the effect of subcultural norms. The correlation matrices for the observed variables are presented in Table 6. Both Sri Lanka and Malaysia have the reputation of providing high quality demographic data, and data from both WFS surveys have undergone intensive scrutiny and are reported to be of high quality (Chander, 1977; Sri Lanka, 1978) Measurement errors for the observed variables are assumed to be equivalent in the two surveys and are adjusted for in the LISREL model. See Appendix for the specification of the LISREL measurement models for both countries.

5.7 Research Design

The present analysis will be performed in two stages. In the first stage, we examine the cross-country differences to see if the culture-institutional factors operate in different manners in Sri Lanka and Malaysia. Data from the two countries are examined with multiple-sample analysis. Several models are estimated and compared. In the first model, all parameters are constrained to be equal between the two countries. If this model is accepted, this suggests that the cultural and structural variables behave in the same manners in Sri Lanka and Malaysia. On the other hand, if this model is rejected, structural invariance between the two countries is suggested. The effects of the explanatory variables on age at marriage and first birth interval will then be specified to vary in the two countries in the subsequent models. The interaction effects can be tested by the difference of chi-squares procedure discussed earlier.

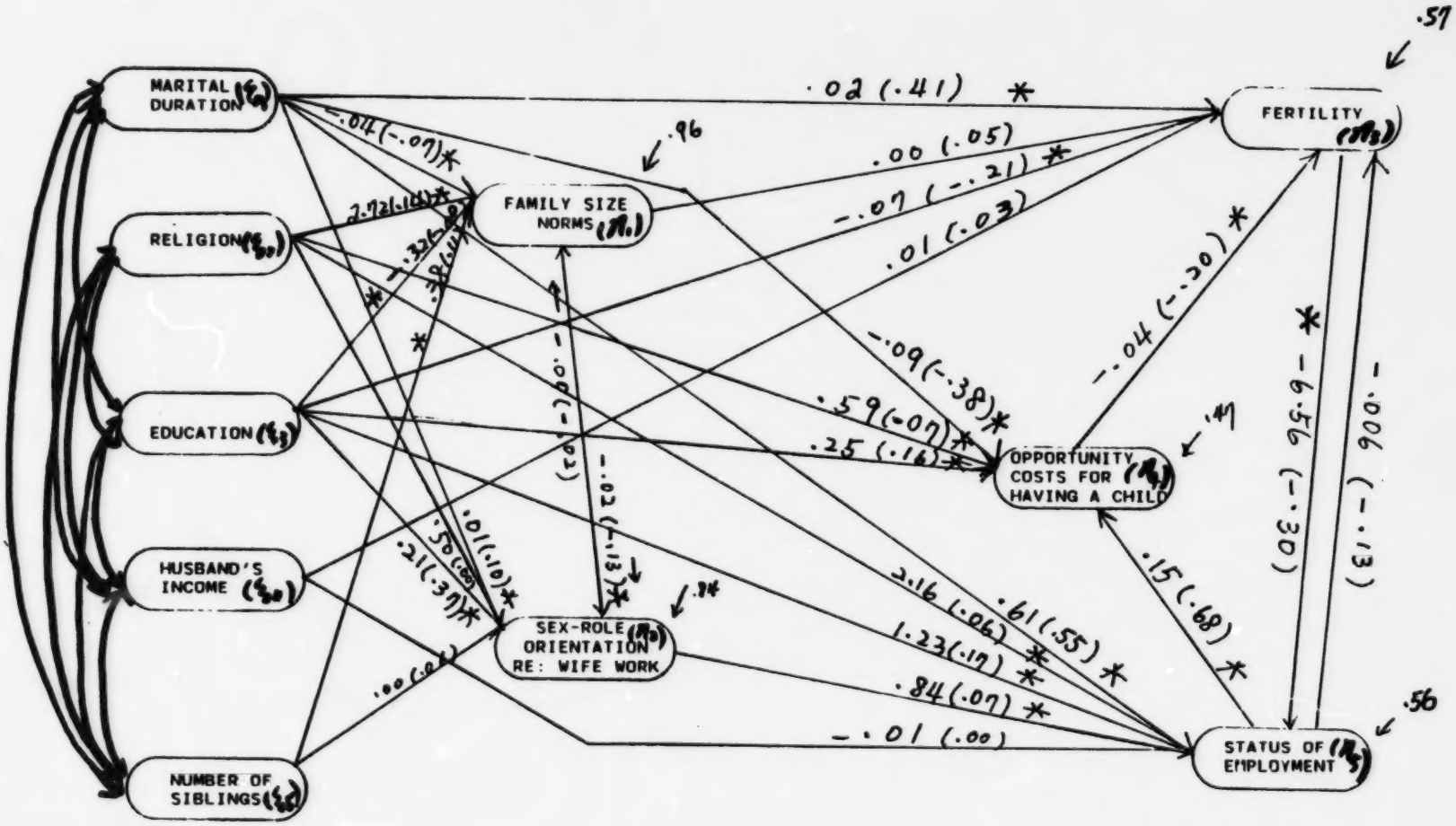
Table 5: Unobserved (Latent) and Observed Variables Incorporated In The LISREL Model

Unobserved Variables	Observed Variables	
Cohort Effect	X_1	Completed Age
Ethnicity 1		Sri Lanka (dummy variables) 0 = Tamils (Hindus)
Ethnicity 2	X_{2s} X_{3s}	1 = Sinhalese (Buddists) 2 = Moors (Muslims)
		Malaysia (dummy variables) 0 = Indians (Hindus)
	X_{2m} X_{3m}	1 = Chinese (Buddists) 2 = Malay (Muslims)
Origin		Childhood Residence 0 = Urban
	X_4	1 = Rural
Spouse's Education	X_5	Years of schooling
Spouse's Occupation	X_6	1 = Not employed 2 = Agricultural work 3 = Skilled/Unskilled(blue lar) 4 = Sales/Service 5 = Professional/Clerical
Respondent's Education	Y_1	Years of schooling
Respondent's Premarital Occupation	Y_2	1 = Not employed 2 = Agricultural work 3 = Skilled/Unskilled(blue lar) 4 = Sales/Service 5 = Professional/Clerical
Age At Marriage	Y_3	Complete years of entering into first marriage
First Birth Interval	Y_4	Interval between marriage and the first live birth (in months, grouped into 8 categories)

Note: See Appendix for LISREL specification of the measurement model (relationship between observed and unobserved variables).

University of Alberta

Figure 5 : LISREL Estimates for the Framework of The Relationship Between Female Employment and Fertility in USA, 1975 with the Value of be(3,5) assumed to be -.006



d.f. = 11, χ^2 = 5.87 (.88)
Goodness Of Fit Index = 1.00
Total Coefficient of Determination
For Structural Equation Model = .73
* : Coefficient significant at .05 level

Table 6: Correlation Matrix For the Observed Variables For Sri Lanka and Malaysia.

Sri Lanka

	X_1	X_{2S}	X_{3S}	X_4	X_5	X_6	Y_1	Y_2	Y_3	Y_4
X_1	1.000									
X_{2S}	.026	1.000								
X_{3S}	-.023	-.408	1.000							
X_4	-.006	-.115	.127	1.000						
X_5	-.055	.023	-.063	.245	1.000					
X_6	-.031	-.015	.040	.307	.501	1.000				
Y_1	-.147	.127	-.175	.230	.589	.482	1.000			
Y_2	-.055	.098	-.101	.088	.216	.207	.282	1.000		
Y_3	.004	.216	-.146	.121	.366	.316	.489	.334	1.000	
Y_4	.042	-.123	.037	-.075	-.082	-.080	-.133	-.062	-.165	1.000

Malaysia

	X_1	X_{2M}	X_{3M}	X_4	X_5	X_6	Y_1	Y_2	Y_3	Y_4
X_1	1.000									
X_{2M}	-.007	1.000								
X_{3M}	.009	-.535	1.000							
X_4	.000	.300	-.338	1.000						
X_5	-.168	.137	-.188	.293	1.000					
X_6	-.113	.210	-.217	.334	.491	1.000				
Y_1	-.280	.106	-.178	.334	.584	.447	1.000			
Y_2	-.140	.249	-.228	.206	.246	.223	.329	1.000		
Y_3	-.141	.436	-.407	.240	.301	.286	.354	.365	1.000	
Y_4	.159	-.236	.234	-.133	-.155	-.142	-.147	-.113	-.313	1.000

In the second stage of analysis, we examine the cross-ethnicity differences and test for the interaction between ethnicity and institutional factors with the multiple-sample analysis. Data for the three ethnic groups within each country will be analyzed simultaneously. A model with equality constraints for all parameters across the ethnic groups is first estimated to test the hypothesis that no interaction effects exist between ethnicity and the structural variables. If this model is rejected, the patterns of interaction are then examined by specifying the coefficients between each structural variable and the two measures of the timing of early family formation to be different across the ethnic groups. Similarly, the difference in chi-square procedure will be used for the significant tests of the interaction.

6. Results

6.1 Cross-Country Comparison

Table 7 presents information of goodness-of-fit for the models for Sri Lanka and Malaysia. The chi-square statistic of each model, the three largest standardized residuals of the parameters in the model, and the test of significant change from one model to the next are presented to help us evaluate the adequacy of alternative models. As indicated from the large chi-square and standardized residuals, the model with equality donstraints for all parameters does not fit the data and should be rejected. This indicates structural invariance between the two countries. In the second model, the effect of ethnicity on age at marriage and first birth interval is specified to be different across the submodels. Although the two Buddist communities (Chinese and Sinhalese) and the two Muslim communities (Malays and Moors) share the same religious affiliations, they have different nationality, histories, nuptiality customs and other aspects of life which make them distinct cultural groups. Hence the impact of the group membership on the timing of family formation may be quite different in the two countries. As shown, a statistically significant improvement in fit is gained when the effect of ethnicity is specified to be different across the countries. However, the model still does not to fit the data. In the subsequent models, we test the hypothesis that the impact of the structural variables are different in the two countries. The effects of structural variables are allowed to vary

Table 7: Information On Goodness of Fit For A Series of Nested Multiple-sample Analysis For the Two Countries as a whole.

Model	d.f	The Three Largest Standardized Residuals in the Model			SIGNIFICANT Chi-Square (P)	IMPROVEMENT
1.	30	-8.5(E2 & WEDU, SL)	8.0(WEDU & AMA, SL)	6.9(WEDU & AMA, MA)	563(.00)	---
2.	26	-7.0(AMA & FBI, SL)	-6.2(AGE & WEMP, MA)	5.8(WEDU & WOCC, MA)	497(.00)	*
3.	22	-8.5(E2 & WEDU, SL)	-7.9(WEDU& AMA, SL)	-7.2(E1 & WED, MA)	403(.00)	*
4.	20	-8.5(E2 & WEDU, SL)	6.7(WEDU & E1, SL)	5.4(E1 & WEDU, MA)	374(.00)	*
5.	18	-8.5	6.7	5.4	373(.00)	n.s.
6.	14	-8.5	6.7	5.4	363(.00)	*

Specificaitons of Each Model:

1.: equality constraints for all parameters.
2 : effects of ethnicity1 and ethnicity2 are freed
3 : 2 + effects of wife's education and employment are freed
4 : 3 + cohort effects are freed
5 : 4 + effects of residential origin are freed
6 : 5 + effects of husband's education and education are freed

* : improvement in fit significant at .05 level
n.s.: no significant improvement

across the two countries. Significant improvement of the fit to the data is gained when this is done. Data indicate that except for urban/rural origin, all other structural variables exert different impact on age at marriage and first birth interval in the two countries. The model, however, continues to fit the data poorly.

In the seventh model the relationship between the exogenous variables and respondent's education and employment are also allowed to be different across countries. Substantial improvement in fit is gained when this is done. Statistics (x^2=3.95, p=.79, df=7) indicate that this model fits the data very well. This substantisl improvement in the goodness-of-fit of the model shows that much of the differences between Malaysia and Sri Lanka can be found in the relationship between the exogenous variables and respondent's education and premarital employment status. LISREL estimations (standardized in parenthesis) for this final model are presented in Figure 3 and 4. The total effects of the explanatory variables on age at marriage and the first birth interval are reported in Table 8.

Some general patterns are observed in both countries. All culture-structural variables, except the group membership of Muslims and urban/rural origin, have significant direct effects on wife's age at marriage in both countries. The membership of each ethnic group in the two countries does not have an equal effect but in both countries Muslims do not significantly differ from Hindus in age at first marriage when other variables are held constant, whereas Buddists do differ from other groups. Most exogenous variables also have indirect effect on age at first marriage through wife's education and, to a lesser extent, through wife's premarital employment status. As expected, part of the effect of wife's education on age at marriage goes through her premarital employment status. The trend toward a shorter interval between marriage and first birth is seen in both countries. The major determinant of the interval between marriage and the first birth is age at marriage. Most socioeconomic variables have little effect on the first birth interval. Age at marriage mediates the effects of most structural variables on first birth interval. Group membership, particularly that of Sinhalese and Chinese, have a particularlly strong total effect on the first birth interval. The Chinese

Figure 3. LISREL Estimates for The Determinants of Early Family Formation Process For Malaysia.

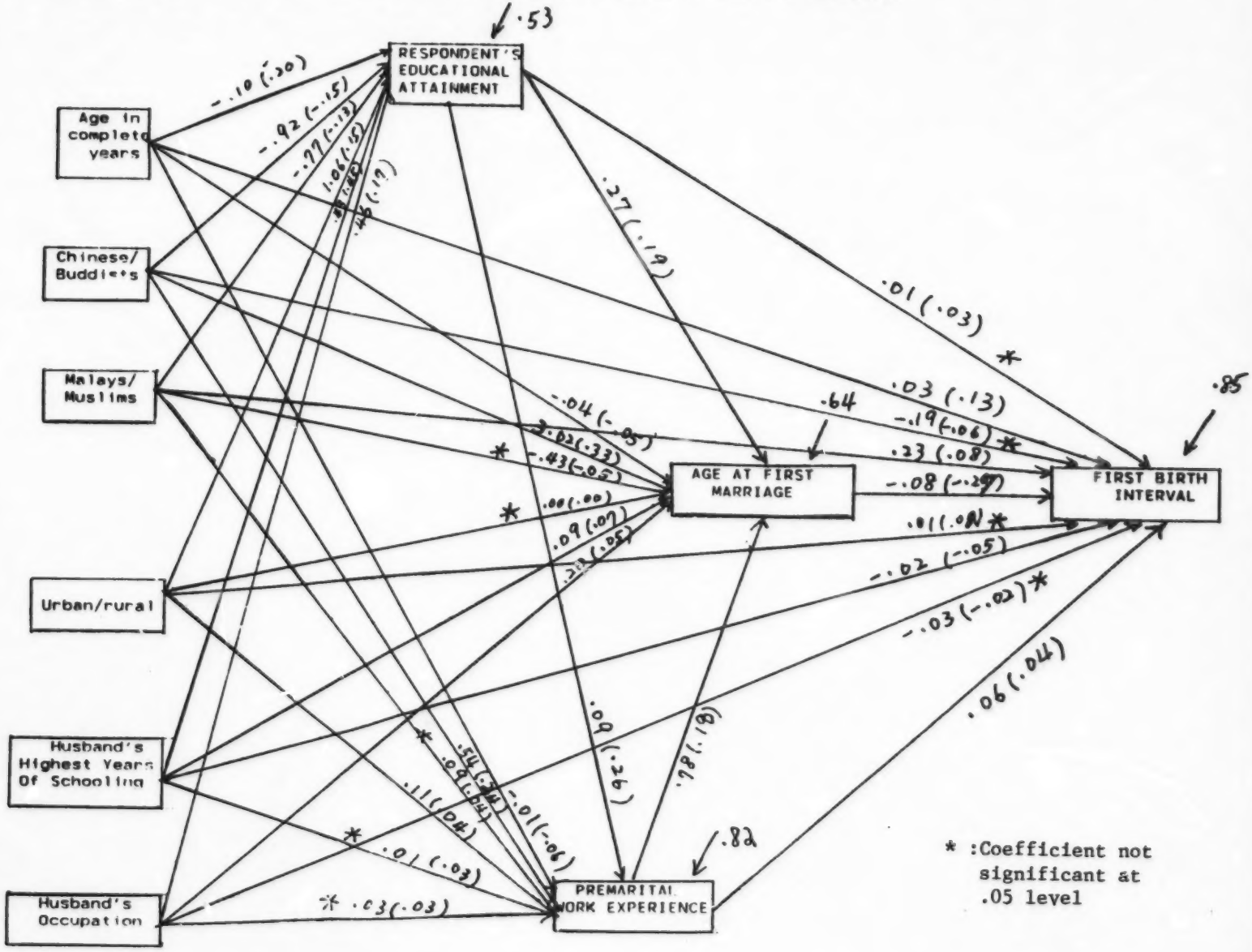


Figure 4. LISREL Model for The Determinants of Early Family Formation Process For Sri Lanka

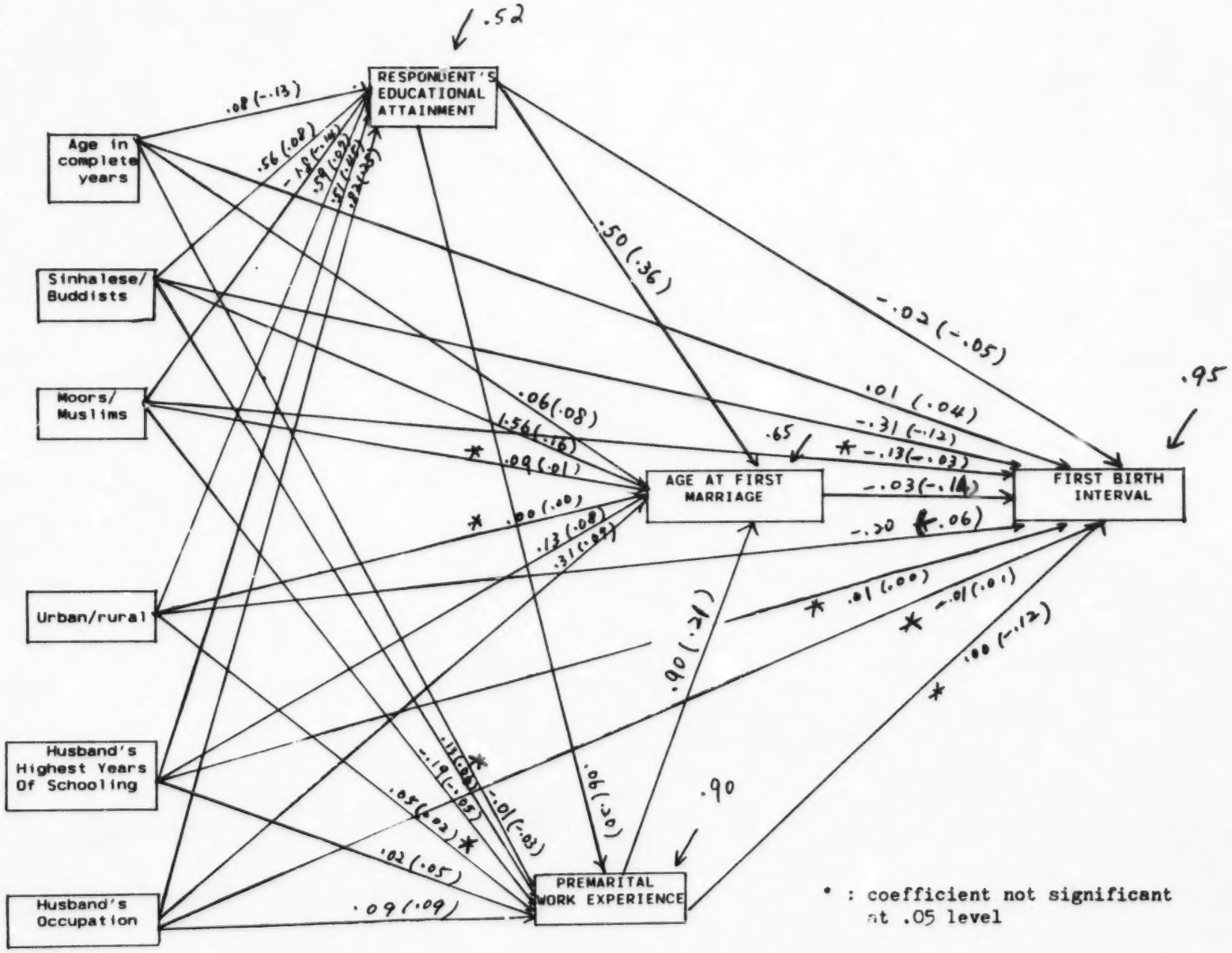


Table 8 : Unstandardized and (Standardized) Total Effects of the Culture-structural Variables On Age At First Marriage and First Birth Interval For Malaysia and Sri Lanka.

	On Age At First Marriage		On First Birth Interval	
	Malaysia	Sri Lanka	Malaysia	Sri Lanka
Ethnicity1	3.13(.34)	2.00(.20)	-.42(-.15)	-.39(-.14)
Ethnicity2	-.62(-.07)	-1.18(-.07)	.27(.10)	-.06(-.01)
Wife's Education	.34(.24)	.56(.40)	-.01(-.01)	-.04(-.04)
Premarital Employment	.78(.18)	.90(.21)	-.01(-.01)	-.03(-.14)
Cohort Eeffect	-.08(-.10)	.02(.02)	.04(.15)	.01(.04)
Origin	.45(.04)	.37(.03)	-.01(.01)	-.22(-.06)
Spouse's Education	.25(.18)	.43(.27)	-.03(-.08)	-.02(-.05)
Spouse's Occupation	.38(.09)	.85(.19)	-.05(-.04)	-.04(-.03)
Age At First Marriage	N.A.	N.A.	-.08(-.27)	-.03(-.14)

and Sinhalese both have a significantly shorter first birth interval than the Hindus. As noted by Hirschman, there is a negative relationship between the age at first marriage and first birth interval and this may in part be biological since postponement of marriage to later years may actually reduce first birth interval which are due to teen-age subfecundity. However, it may also reflect a desire to have the first child no later than a certain young age. Couples may delay marriage, but may try to make up for the lost time after marriage.

Differences across the countries are also noted. In Malaysia, the group membership of Chinese has the strongest impact on the age at marriage (see both direct and total effects). The Chinese marry three years later than the Indians when the other socioeconomic variables are held constant. In Sri Lanka, however, wife's education is the most important factor followed by wife's employment status. As expected, the effect of education on age at marriage is considerably stronger in Sri Lanka. The total effect indicates that for each additional year of wife's schooling, there is a greater delay of marriage by .22 years in Sri Lanka than in Malaysia. Structural variables have a stronger impact on age at first marriage in Sri Lanka than in Malaysia (except for the effects of urban/rural origin, which is slightly larger in Malaysia). Somewhat surprisingly, the trend of later age at first marriage is found in Malaysia but not in Sri Lanka. The total effect of this trend factor (age) is more important in Malaysia. This may reflect that the downward trend in age at marriage occurred earlier in Malaysia. However, since the analysis is restricted to married women aged 30 and above (who were born approximately during 1925 and 1945) and the changes in the younger cohorts are not examined, present data do not permit us to reach such a conclusion. Spouse's characteristics, especially husband's education, have a significantly stronger impact on women's age at marriage in Sri Lanka. In brief, age at marriage appears to be more responsive to the modernization factors in Sri Lanka whereas the cohort effects and ethnic membership seem to be the more important determinants of the timing of first marriage in Malaysia.

The patterns observed for the first birth interval between the two countries are not as distinct. The differnces in the first birth interval among the ethnic groups are greater in Malaysia. This is

consistent with the pattern observed earlier that membership of each ethnic group is a more significant determinant of the early family formation in Malaysia. In Sri Lanka, wife's education has a significant direct effect on the interval while wife's premarital work role does not have a significant impact. In Malaysia, however, this pattern is reversed. Education does not have a direct impact on the first birth interval while female's employment does. This may reflect the impact of the special efforts of Sri Lankan and Malaysian governments to promote education and female employment in their countries respectively.

6.2 Cross-Ethnicity Comparison

The significant effect of country/ethnicity, as shown in the above analysis, justifies a separate analysis for each country and ethnic group. We now turn to look in detail at the situation within each ethnic group and examine the interaction effect between ethnicity and the structural variables. Table 9 presents the information on the goodness-of-fit for a series of multiple-sample analysis. The three ethnic groups within each country are analyzed simultaneously. The chi-square statistic and the large standardized residuals for the parameters for the first model in which all parameters are specified to be equal across the ethnic groups indicate that this model does not fit the data and therefore should be rejected. This points to interaction effects between ethnicity and some (or all) of the socioeconomic variables. Models 2 to 5 test the interaction between ethnicity and the structural variables. The model for Malaysia fits progressively better as the effect of the structural variables are allowed to vary across the ethnic groups.This indicates that significant interaction effects exist between ethnicity and all explanatory variables except rural-urban origin in determining the timing of early family formation. The model for Sri Lanka gains no significant improvement when the same model specifications are estimated, except when the the effect of urban/rural origin is relaxed. This indicates that all structural variables, except for one's origin, operate in a similar way among the three ethnic groups of Sri Lanka. A final model allows the effects of the exogenous variables to be different across the ethnic groups. Statistics indicate that this model fits the data very well in both countries (Malaysia: $x^2=3.11$, $p=.54$; Sri Lanka: $x^2=11.6$, $p=.90$). The deviation of the

Table 9: Information On Goodness of Fit For A Series Of Stack Models Estimated For the Three Ethnic Groups Within Malaysia and Sri Lanka.

Model	d.f.	The Three Largest Standardized Residuals in the Model			SIGNIFICANT Chi-square (P)	IMPROVEMENT
			MALAYSIA			
1.	44	7.0(AMA & FIB, MAL)	-6.2(AGE,WEMP, CH)	5.8(WEDU & WENP)	319(.00)	---
2.	36	-6.2(AGE & WEMP, CH)	5.7(WED & WEMP, CH)	-5.6(AMA & FBI, MA)	287(.00)	*
3.	32	-6.2	5.7	-5.6	265(.00)	*
4.	28	-6.2	5.7	-5.6	262(.00)	n.s.
5.	20	-6.2	5.7	-5.6	238(.00)	*
			SRI LANKA			
1.	44	-5.7(WED & WEMP, TAM)	5.3(WEMP & HOCC, SIN)	5.0(WEMP & HOCC, TAM)	199(.00)	----
2.	36	-5.7	5.3	5.0	187(.00)	n.s.
3.	32	-5.7	5.3	5.0	184(.00)	n.s.
4.	28	-5.7	5.3	5.0	168(.00)	*
5.	20	-5.7	5.3	5.0	159(.00)	n.s.

Specifications for each model:

1.: equality constraints for all parameters.
2 : effects of wife's education and employment are freed
3 : 2 + cohort effects are freed
4 : 3 + effects of residential origin are freed
5 : 4 + effects of husband's education and occupation are freed

* : improvement in fit significant at .05 level
n.s.: no significant improvement

model-implied covariance from the covariance of the observed data is insignificant and can be attributed to mere sampling fluctuations. Unstandardized (standardized in parentheses) effect coefficients for this final model for both countries are shown in Table 10 and 11. The total effects (direct plus indirect effects) of each socioeconomic variable on the two dependent variables are also shown in Table 12.

The predominant influence of wife's education and premarital work role is consistent across the groups, except for the Moors, to whom the urban/rural origin has a stronger impact than her premarital employment status. Wife's education has the highest total effect on age at marriage in every ethnic group. It is especially important for the Sinhalese. All variables, except residential origin, have direct effect on age at marriage in every group. The exogenous variables also have indirect effect through respondent's education. Husband's education has an especially strong effect for the two Hindu communities (Tamils and Malaysian Indians). This may be reflecting the importance of marriage partner's characteristics under the influence of dowry and the caste system for these two groups. It is somewhat puzzling to find a positive cohort effect on age at first marriage for the three ethnic groups in Sri Lanka and for the Malaysian Indians. The negative effect of the trend factor is seen only for the Chinese and the Malays. Residence origin has no significant effect on both dependent variables, except for the Moors who, as pointed out earlier, are most urban among the six ethnic groups. Overall, the differences in the effect of the structural variables on the timing of early family formation is smaller among the ethnic groups in Sri Lanka than in Malaysia.

The explained variance in age at marriage range from 36% for the Indian community to 16% for the Malay community. A much smaller percentage of variance is explained for the Chinese and the Malays. The hypothesis that the structural variables are stronger determinants for the two Buddist groups, the Chinese and the Sinhalese is only partially supported in Sri Lanka although the differences are not substantial in Sri Lanka either. The lower percentage of the explained variance for the Tamils and the Moors may be reflecting a stronger subgroup nuptiality norms and customs in these two groups, especially for the Tamils. In Malaysia, countrary to our expectation, the structural variables

Table 10: Unstandardized (standardized in parentheses) Coefficients for the Socioeconomic Variables on the Age at First Marriage For the Six Major Ethnic Groups in Sri Lanka and Malaysia.

	MALAYSIA			SRI LANKA		
	Chinese	Malay	Indian	Sinhalese	Moors	Tamils
WED	.21(.17)	.29(.20)	.34(.28)	.49(.39)	.43(.27)	.42(.33)
WEMP	.71(.21)	.90(.21)	.82(.21)	.89(.21)	.76(.11)	.92(.20)
AGE	-.07(-.10)	-.04(-.06)	.12(.16)	.07(.07)	.06(.08)	.07(.09)
RESI	-.04(-.01)*	-.04(.00)*	-.04(-.00)*	-.01(-.02)*	1.70(.19)	-.01(-.02)*
HED	.10(.08)	.07(.06)	.22(.18)	.08(.05)	.11(.08)	.13(.11)
HOC	-.05(-.01)*	.27(.08)	.43(.13)	.43(.09)	.43(.10)	.30(.07)
R^2	.17	.16	.36	.33	.30	.27

Definition of the Notations:
WED: respondent's education, WEMP: premarital employment status
AGE: cohort effects, RES: residential origin,
HED: husband's education, HOC: husband's occupation
* : coefficient not significant at .05 level

Table 11: Unstandardized (standardized in parentheses) Coefficients for the Socioeconomic Variables on The First Birth Interval For the Six Major Ethnic Groups in Sri Lanka and Malaysia.

	MALAYSIA			SRI LANKA		
	Chinese	Malay	Indian	Sinhalese	Moors	Tamils
WED	.01(.02)*	.02(.03)*	.04(.11)*	-.02(-.06)*	-.02(-.04)*	-.02(-.05)*
WEMP	.00(.00)*	.09(.05)	-.12(-.09)*	.02(.01)*	.02(.01)*	.02(.01)*
AGE	.03(.17)	.03(.11)	.05(.19)	.01(.05)	.01(.00)*	.01(.02)*
RESI	-.12(-.06)	-.12(-.03)	-.12(-.04)	-.17(-.05)	-.17(-.06)	-.08(-.02)*
HED	-.01(-.03)*	-.04(-.08)	.03(.07)*	.00(.01)*	.01(.02)*	.00(.01)*
HOC	.05(.05)*	-.01(-.01)*	-.17(-.16)	-.02(-.02)*	-.03(-.02)*	-.05(-.04)*
AMA	-.01(-.06)*	-.13(-.32)	-.08(-.23)	-.03(-.12)	-.08(-.28)	-.03(-.09)*
R^2	.04	.14	.11	.03	.09	.02

Definition of the Notations:
WED: respondent's education, WEMP: premarital employment status
AGE: cohort effects, RES: residential origin,
HED: husband's education, HOC: husband's occupation
* : coefficient not significant at .05 level

Table 12: Unstandardized (standardized in parenthesis) Total Effects of the Socioeconomic Variables on Age At First Marriage and First Birth Interval For The Ethnic Groups in Malaysia and Sri Lanka

	WED	WEMP	AGE	RES	HED	HOC	AMA
				MALAYS			
AMA	.35(.25)	.90(.21)	-.08(-.12)	.33(.03)	.19(.15)	.44(.12)	N.A.
FBI	-.03(-.07)	-.03(-.02)	.04(.14)	-.14(-.03)	-.06(-.12)	-.05(-.04)	-.13(-.32)
				CHINESE			
AMA	.28(.22)	.71(.21)	-.13(-.19)	.39(.05)	.26(.20)	.15(.04)	N.A.
FBI	-.00(.00)	-.01(-.01)	.03(.18)	-.12(-.06)	-.01(-.03)	.05(.05)	-.01(-.12)
				INDIANS			
AMA	.44(.35)	.82(.21)	.10(.13)	.23(.03)	.40(.33)	.77(.23)	N.A.
FBI	-.00(-.02)	-.18(-.14)	.04(.15)	-.12(-.04)	.00(.01)	-.19(-.17)	-.08(-.28)
				MOORS			
AMA	.49(.29)	.76(.11)	.02(.04)	2.21(.26)	.31(.21)	.56(.13)	N.A.
FBI	-.09(-.05)	-.00(.00)	.00(.01)	-.25(-.10)	-.01(-.02)	-.05(-.04)	-.08(-.05)
				SINHALESE			
AMA	.61(.44)	.89(.21)	.00(.01)	.39(.03)	.40(.26)	1.11(.24)	N.A.
FBI	-.02(-.09)	-.01(-.03)	.03(.06)	-.01(-.06)	-.01(-.04)	-.00(-.06)	-.03(-.24)
				TAMILS			
AMA	.42(.34)	.92(.20)	.05(.07)	.10(.01)	.50(.37)	.29(.08)	N.A.
FBI	-.03(-.12)	-.07(-.01)	.01(.03)	-.02(-.06)	-.03(-.04)	-.08(-.02)	-.03(-.07)

Definition of the Notations:

AMA: age at first marriage, FBI: first birth interval
WED: respondent's education, WEMP: premarital employment status
RES: residential origin, HED: husband's education
HOC: husband's occupation,

account for a smaller amount of within group variation for the Chinese than they do for the Malays and Indians. This result may be interpreted in two ways. It may suggest that other structural variables which are not included in the model (e.g. family structure, sex ratio, etc.) are more important for the Chinese and the Malays. It may also be suggesting that factors other than the nuptiality and fertility norms among the ethnic groups in Malaysia, particularly the Chinese and the Malays, are important in explaining the distinct patterns in their family building behavior. A plausible explanation may be the political tension between the Chinese and the Malays. Although the political power in Malaysia has been in the hands of Malays, Chinese are economically more advantaged. The economic success of the Chinese may be threatening to the Malays. Thus, the desire for the Malays to maintain the numerical majority in this country may become stronger and be reflected in their behavior of marrying at an earlier age. On the other hand, the Chinese may opt for postponimg their marriage in order to achieve a higher social status in Malaysia. Such psychological factors may be important in the decision making process of early family formation. However, the present data do not allow us to examine these dimensions.

From Table 11 and Table 12, we can see that the socioeconomic variables have little impact on the first birth interval in every group. The cohort effect (age) and urban/rural origin have some impact on the interval only for the three ethnic groups in Malaysia and the Sinhalese. This again points to the fact that the trend factor is a more important factor in Malaysia. The structural variables do not have significant direct impact on the first birth interval. Age at marriage is the most important determinant which mediates the effect of other socioeconomic variables for most groups. It is especially important for the Malays and the Moors. For the Chinese and the Tamils, even age at marriage does not have any significant impact on the first birth interval. The small variance explained by the structural variables observed in each group may be a reflection of the absence of many other important explanatory variables for the initial family formation such as attributes of family origin (parent's educational attainment, occupation and religion, age at which the parents married, number of siblings and whether the parental family remain intact, etc.) and the intermediate variables such as contraceptive practice and the frequencies of sexual intercourse. The structural variables included in

the model are not able to explain the within-group variations in the interval between marriage and the first birth. The R^2s for Chinese, Sinhalese and Tamils are especially small.

7. Conclusion and Discussion

The results suggest that the cultural and institutional factors have varying degrees of importance in Sri Lanka and Malayasia. The group membership of the Chinese is an especially important factor in determining the timing of family formation in Malaysia. In Sri Lanka, the impact of educational attainment is especially noteworthy. The hypothesis that the structural variables interact with ethnicity in determining the timing of early family formation is supported by the findings in Malaysia. In Sri Lanka, only the urban/rural origin interacts with ethnicity.

In general, the results suggest that ethnicity, independent of structural variables, exerts sizeable effects on the age at marriage. Socioeconomic variables are able to explain a considerable amount of variation in age at first marriage within each ethnic group. The differentials in the pace of family formation should be regarded as resulting from the interplay between structural and the history and traditions of particular groups. Although it cannot be ascertained, given the lack of direct measures of the subcultural norms and customs, the differences among the various ethnic groups may to a great extent reflect subcultural effects. However, to what extent the subcultural effects reflect the subgroup nuptiality and fertility norms remains unknown. It is possible that other dimensions such as psychological factors are involved in the subcultural effect. This can be seen from the low explanatory power of the structural variables, which implies a stronger subgroup effect, for the Chinese. Since no clear subgroup norms which subscribe early family formation are found for the members in this community, the subcultural effect may be reflecting other dimensions of life for this group. The present data do not allow us to explore this hypothesis. Further research is needed to substantiate this conclusion.

We have demonstrated in this paper how LISREL can be used to examine the nonadditive relationship among variables. LISREL analysis avoids the practical difficulties with regard to the

identification and substantive interpretation of the interaction effects often encountered in methods of adding cross-product terms to regression model and dummy variable regression or MCA. LISREL also provides some information that are not readily available in these other methods. They include cross-country and ethnicity comparisons, indirect and total effects, tests of the adequacy of the causal model. In comparison to the method of separate regression analysis for subpopulations, the LISREL multiple-sample analysis has the virtue of being capable of testing the statistical interaction in a relatively easier manner, especially when multiple interaction exists among the variables in interest. It can also analyze more groups simultaneously.

Although higher-order interaction and interaction involving continuous variables can be analyzed with LISREL with a more complicated research design, more sophisticated knowledge of LISREL is required for these kinds of analysis. This topic is beyond the scope of this paper. Interested readers can consult several references (Joreskog, 1981; Sorbom, 1982; Sorbom and Joreskog, 1981; Masden, 1983; Hayduk, 1984). The multiple-sample analysis presented in this paper is a straight forward extension of the basic LISREL model. It is relatively easier and practical for most researchers in sociology to use. For most sociological research, this method would usually serve the purpose of disentangling the joint effects of variables in interest, since most of our sociological theories have not reached the level of sophistication where higher-order interaction or more complicated patterns of nonadditivity can be clearly specified.

The multiple-sample analysis used in this context has certain limitations. The first limitation has to do with the assumption of linearity made in LISREL analysis. Nonlinear relationship is difficult to analyze with this method. However, this is a limitation shared by other least squares estimations. Secondly, a large sample size (greater than 200, as a rule of thumb) is required in order to obtain reliable estimates in the model due to the asymptotic property of the likelihood statistic. Thirdly, several alternative models might result in similarly acceptable fits. Finding an insignificant chi-square does not prove that one has located "the right model". It indicates that one has located a model that is consistent with the data. Thus, different models may be acceptable. The decision to use

one or the other model has to be made on theoretical grounds. A related issue is that the large amount of information generated from this method may be hard to interpret without theories. A technical difficulty of LISREL analysis is that the analysis is more costly than the other methods discussed earlier. To be cost efficient, analysis needs to be guided by sound theoretical framework, or else researchers are likely to find themselves lost in the analysis. This theory demanding characteristic of LISREL, however, is believed to be one of the advantages of this method. In the process of research, researchers would hopefully develop more adequate theories and subject them to empirical tests. In this regard, LISREL may help to bridge the gap between theory and operation in sociological research mentioned at the outset of this paper.

Acknowledgement

This author would like to thank Dr. John Gartrell, Dr, G. Jarvis, Dr, H. Krahn, Dr. Karol J. Krotki and Dr. Frank Trovato for their comments on an earlier draft of this paper.

References

Abhayaratne, O. E. R. and C. H. S. Jayewardene
1967 Fertility Trends In Ceylon. Colombo: Apothecaries.

Alba, R.D. and G. Moore
1982 "Ethnicity in The American Elite". American Sociological Review 47: 373-83.

Allison, Paul D.
1977 "Testing for Interaction in Multiple Regression" American Journal of Sociology, 83: 144-153.

Althauser, R. P.
1971 "Multicollinearity and Non-additive Regresion Models", pp.453-72 in H. M. Blalock Jr. (ed.) , Causal Models in the Social Sciences Chicago, Aldine-Atherton.

Alwin, D.F. and D.J. Jackson
1981 "Application of Simultaneous Analysis to Issues of Factorial Invariance" in D. Jackson and E. F. Borgatta (ed.) Factor Analysis and Measurement in Sociological Research. Beverly Hills: Sage.

Alwin, D. F. and R. Thornton
1984 "Family Origins and The Schooling Process: Early Versus Late Influence of Parental Characteristics." American Sociological Review 49: 784-802.

Baldassare, M.
1981 "The Effects Of Household Density On Subgroups". American Sociological Review 46: 110-118.

Baron, J. N. and Bielby W. T.
1982 "Workers and Machines: Dimensions and Determinants of Technical Relations In The Workplace". American Sociological Review 47: 175-88.

Bechtoldt, H. P.
1974 "Alternative Approaches to Factorial Invariance." Psychometrica 37: 425-40.

Bentler, P. M. and D. G. Bonett
1980 "Significance Tests and Goodness of Fit in The Analysis of Covariance Structures". Psychological Bulletin 88(3): 588-606.

Berk, R. A.
1983 "An Introduction To Sample Selection Biase In Sociological Data". American Sociological Review 48: 386-98.

Berk, R. A. and P. J. Newton
1985 "Does Arrest Really Deter Wife Battery ?" American Sociological Review 50: 253-62.

Blake, J.
1985 "Number of Siblings and Educational Mobility". American Sociological Review 50: 84-93.

Blalock, H. M. Jr.

1960 Social Statistics. First edition. New York, McGraw-Hill.

1971 Causal Models in the Social Sciences. ALdine Atherton, Chicago, N. Y.

1964 Causal Inference in Nonexperimental Research Chapel-Hill. University of Northe Carolina Press.

1965 "Theory Building and The Concept of Interaction". American Sociological Review, 30 (June): 374-81.

1971 Causal Models in the Social Sciences. ALdine Atherton, Chicago, N. Y.

1979 "The Presidential Address: Measurement and Conceptualization Problems: The Major Obstacle to Integrating Theory and Research." American Sociological Research 44: 881-94.

1979 "Dilemmas and Strategies of Theory Construction." pp. 119-35. in W. E. Snizek, E. R. Fuhrman and M. K. Miller (eds.) Contermporary Issues in Theory and Research. Westport, Conn: Greenwood.

Bloxom, B.

1972 "A Confirmatory Analysis of the Factor Stability Hypothesis." Psychometrica 39: 319-26.

Bohrnsted, George W. and Gerald Marwell

1978 "The Reliability of Products of Two Random Variables." pp. 254-273, in K. F. Schuessler (ed.) Sociological Methodology. San Francisco: Jossey-Bass.

Bose, C. E. and P. H. Rossi

1983 "Gender and Jobs: Prestige Standings of Occupation As Affected By Gender". American Sociological Review 48: 316-30.

Bradshaw, Y. W.

1985 "Dependent Development In Black Africa". American Sociological Review 50: 195-207.

Bumpass, L. R.

1969 "Age at Marriage As A Variable in Socioeconomic Differentials in Fertility". Demography 6(1): 45-54.

Bumpass, L. R. Rindfuss and R. Janosik

1973 "Age and Marital Status At First Birth and Pace of Subsequent Fertility". Demography 15: 75-86.

Burk, Perter J. and K. Schuessler

1974 "Alternative Approaches to Analysis of Variance Tables." pp. 145-88, in Sociological Methodology 1973-4. Herbert L. Costner (ed.), San Francisco: Jossey-Bass.

Burt, C.
1939 "The Relations of Educational Abilities" . British Journal of Educational Psychology 9: 45-71.

Chander, V. Palan, et. al.
1977 Malaysian Fertility and family Survey, 1974. First Country Report. Department of Statistics and National Family Planning Board. Malaysia, Kuala Lumpur.

Cherlin, A. and P. B. Walters
1981 "Trends in U.S. Men's and Women's Sex-Role Attitudes: 1972 to 1978" American Sociological Review 46: 453-60.

Cho L. J. and D. R. Retherford
1974 "Comparative Analysis of Recent Fertility Trends in East Asia" in IUSSP, International Population Conference, 1973 Proceedings. Liege, 2: 163-81. Liege: IUSSP.

Choldin, F. M. and C. Hanson
1984 "Status Shifts Without The City". American Sociological Review 47: 129-41.

Cochrane, Susan H.
1979 Fertility and Education: What Do We Really Know ?" Baltimore, John Hopkins University Press.

Cohen, L. E., J. R. Kluegel and K. C. Land
1981 "Social Inequality and Crimianl Victimization ". American Sociological Review 46: 505-24.

Coverman, S.
1983 "Gender, Domestic Labor Time and Wage Inequality". American Sociological Review 48: 623-37.

Crader, K. W. and W. M. Wentworth
1984 "A Structural Reinterpretation Of Responsibility, Risk, and Helping In Small Collectives of Children" . American Sociological Review 49: 611-19.

Davis, K.
1963 "The Theory of Change and Response in Modern Demographic History", Population Index (Princeton) 29(4): 345-65.

DiMaggio, P.
1982 "Cultural Capital And School Success: The Impact of Status Culture Participation On The Grades of U.S. High School Students". American Sociological Review 47: 189-201.

Dixon, R. B.
1971 "Explaining Cross-cultural Variation in Age at Marriage and Proportion Never Married". Pouplation and Development Review , ? : 215-233.

1978 "Late Marriage and Non-marriage as Demographic Responses: Are they Similar ?" Population Studies 32(3): 449-66.

Duza, M. Badrud and C. Stephen Baldwin
1977 Nuptiality and Population Policy. The Population Council. New York.

Ebanks, G. Edward
1986 "A Comparative Analysis of Age At First Marriage in Developing Societies." paper presented at the annual meeting of Canadian Population Societies.

Erickson, B. H. and T. A. Nosanchuk
1984 "The Allocation of Esteem and Disesteem: A Test of Goode's Theory". American Sociological Review 49: 648-58.

Feinberg, W. E.
1985 "Are Affirmative Action and Economic Growth Alterntive Paths To Racial Equality ?". American Sociological Review 50: 561-71.

Fossett, M. and G. Swicegood
1982 "Rediscovering City Differences In Racial Occupational Inequality". American Sociological Review 47: 681-89.

Galaskiewicz, J.
1985 "Professional Networks and The Institutionalization Of a Single Mind Set". American Sociological Review 50: 639-58.

Goldscheider C. and P. R. Uhlenberg
1969 "Minority Group Status and Fertility". American Journal of Sociology 74: 361-72.

Gorden, R. A.
1968 "Issues in Multiple Regression", American Journal of Sociology, 73: 592-616.

Gottfredsosn, D. C.
1981 "Black-White Differences In The Educational Attainment Process: What Have We Learned ?". American Sociological Review 46: 542-57.

Gujarati, Damodar
1970 "Use of Dummy Variable in Testing for Equality Between Sets of Coefficients in Two Linear Regression : a generalization. American Statistician 24: 18, 50-2.

Guterbock, T. M. and B. London
1983 "Race, Political Orientation, and Participation: An Empirical Test of Four Competing Theories". American Sociological Review 48: 439-453.

Hajnal, J.
1953 "Age at Marriage and Proportions Marrying" Population Studies 76: 111-36.

Hayduk, L.
1984 Structural Equation Modelling with LISREL : an Introduction. University of Alberta. (in print draft)

Henretta, J. C.
1984 "Parental Status and Child's Home Ownership". American Sociological Review 49: 131-40.

Hicks, A.
1984 "Elections, Keynes, Bureaucracy and Class: Explaning U. S. Budget Deficits, 1961-1978". American Sociological Review 49: 165-82.

Hirschman C.
1985 " Premarital Socioeconomic Roles and The Timing of Family Formation: A Comparative Stury of Five Asian Societies." Demography 22: 35-58.

Hirschman, C. and R. R. Rindfuss
1980 "Social, Cultural and Economic Determinants of age at birth of first child in Peninsular Malaysia." Population Studies, 34: 506-18.

Hodson, R.
1984 "Companies, Industries and The Measurement Of Economic Segmentation". American Sociological Review 49: 335-48.

Hoelter, Jon W.
1983 "Factorial Invariance and Self-esteem: Reassessing Race and Sex Differences" Social Forces 61: 835-46.

1984 "The Analysis of Covariance Structures: Goodness of Fit Indices". Sociological Methods and Research 11: 325-44.

Hofferth, S. L. and K. A. Moore
1979 "Age At First Birth And Later Economic Well-being. American Sociological Review, 44: 784-815.

Hope, keith
1982 "Vertical and Nonvertical Class Mobility In Three Countries". American Sociological Review 47: 99-113.

Hout, M.
1984 "Occupational Mobility of Black Men: 1962 - 1975". American Sociological Review 49: 308-22.

Howell, and W. Frese
1983 "Size of Place, Residential Preferences and The Life Cycle: How People Come To Like Where They Live". American Sociological Review 48: 569-80.

Jacob, J.
1983 "Industrial Sector and Career Mobility Reconsidered". American Sociological Review 48: 415-21.

Jasso, G.
1985 "Marital Coital Frequency and The Passage of Spouses' Age and Marital Duration, Birth and Marriage Cohorts and Period Influence". American Sociological Review 50: 224-41.

Joreskog, K. G.
1970 "A General Method for Analysis Of Covariance Structures", Biometricka 57:239-51.

1971 "Simultaneous Factor Analysis In Several Populations", Psychometrika 36: 409-26.

1978 LISREL IV: Analysis of Linear Structural Relationship by the Method of Maximum Likelihood. Chicago: International Educational Services.

1981 "Analysis of Covariance Structures." Scandinavian Journal of Statistics 8: 65-92.

Joreskog, K. and Sorbom
1984 LISREL VI: Analysis of Linear Structural Relationship by Maximum Likelihood. Instrumental Variables and Least Squares Methods, Mooresville, Indiana: Scientific Software Inc.

Judd, C. M., J. A. Krosnick and M. A. Milburn
1981 "Political Involvement and Attitude Structure In The General Public". American Sociological Review 46: 660-69.

Kerckhoff, A. C., R. T. Campbell and J. M. Troff
1982 "Dimensions Of Educational and Occupational Attainment in Great Britain". American Sociological Review 47: 347-64.

Kessler, R. C.
1982 "A Disaggregation of The Relationship Between Socioeconomic Status and Psyschological Distress". American Sociological Review 47: 752-64.

Kessler, R. C. and J. D. Mcleod
1984 "Sex Differences In Vulnerability to Undesirable Life Events". American Sociological Review 49: 620-631.

Kessler, R. C. and McRae, J. A. Jr.
1981 "Trends In The Relationship Between Sex and Psychological Distress: 1957-1976". American Sociological Review 46: 443-452.

Knoke, D.
1981 "Commitment And Detachment In Voluntary Associations". American Sociological Review 46: 141-58.

Knonel J.
1977 "Family Limitation And Fertility Transition: Evidence From Age Patterns of Fertility in Europe and Asia". Population Studies 31: 219-43.

Liker, J. K. and G. H. Elder, Jr.
1983 "Economic Hardship and Marital Relationship In the 1930s". American Sociological Review 48: 343-59.

Lin, N., W. M. Ensel and J. C. Vanghn
1981 "Social Resources and Strength of Ties: Structural Factors In Occupational Status Attainment". American Sociological Review 46: 393-405.

Lincoln, J. R. and A. L. Kalleberg
1985 "Work Organization and Workforce Commitment: A Study of Plants and Employees in The U.S. and Japan". American Sociological Review 50: 738-60.

Logan, J. R. and M. Schneider
1981 "The Stratification of Metropolitan Suburbs, 1960-1970". American Sociological Review 46: 175-86.

Logan, J. R. and O. A. Collver
1983 "Resident's Perceptions of Suburban Community Differences". American Sociological Review 48: 428-33.

Lomax, Richard G.
1983 "A Guide to Multiple-sample Structural Equation Modeling." Behavior Research Methods and Instrumentation 15(6): 580-4.

Long, J. Scott.
1976 "Estimation and Hypothesis Testing On Linear Models Containing Measurement Error: A Review of Joreskog's Model for the Analysis of Covariance Structures." , Sociological Methods and Research 5(2):157-206.

1983 Covariance Structure Models: An Introduction to LISREL. Quantitative Applications in the Social Sciences Series number 07-033. Beverly Hills: Sage.

Lorence, Jon and J. T. Mortimer
1985 "Job Involvement Through The LIfe Course : A Panel Study of Three Age Groups". American Sociological Review 50: 618-38.

Mare, R. D.
1981 "Change and Stability In Educational Stratification". American Sociological Review 46: 72-87.

Mare, R. and C. Winship
1984 "The Paradox Of Lessening Racial Inequality and Joblessness Among Black Youth: Enrollment, Enlistment and Employment, 1964-81". American Sociological Review 49: 39-55.

Marini, M. M.
1978 "The Transition to Adulthood: Sex Differences in Educational Attainment and Age At Marriage." American Sociological Review 43: 483-507.

Marsden, peter V.
1983 "On Interaction Effects Involving Block Variables" Sociological Methods and Research 11(3): 305-23.

Mauldin, W. P.
1981 "The Determinants of Fertility Decline in LDCs: An Overview of The Available Empirical Evidence." International. Population Conference: Manila, 1981, Liege: IUSSP 1: 5-24

McGaw, B. and K. G. Joreskog
1971 "Factorial Invariance of Ability Measures in Groups Differing in Intelligence and Socioeconomic Status" British Journal of Mathematical and Statistical Psychology 24: 154-68.

McRoberts, H. H. and K. Selbee
1981 "Trends In Occupational Mobility In Canada and The United States". American Sociological Review 46: 406-421.

Mitchell, R. E.
1971 "Changes in Fertility Rates and Family Size in Response to Changes in Age At Marriage, and The Trend Away From Arranged Marriages, and Increasing Urbanization." Population Studies 25: 481-89.

Modell, J.
1979 "The Marriage Transition: Normative Aspects Of Change Since World War II", paper presented at meetings of the population Association of America, Philadelphia.

Moore, K. A. and S. Hofferth
1980 "Factors Affecting Early Family Formation: A Path Model". Population and Environment 3(1): 73-96.

Neidert, L. J. and R. Farley
1985 "Assimilation In the United States: An Analysis of Ethnic and Generation Differences in Status and Achievement". American Sociological Review 50: 840-50.

Nelson, H. M.
1981 "Religious Conformity in Age of Disbelif: Contextual Effects Of Time, Denomination and Family Processes Upon Church Decline and Apostasy". American Sociological Review 46: 632-40.

Oliver, P.
1984 "If You Don't Do It, Nobody Else Will: Active and Token Contributors to Local Collective Action". American Sociological Review 49: 601-10.

Peterson, R. D. and J. Hagan
1984 "Changing Conception of Race: Toward An Account of Anomalous Findings of Sentencing Research". American Sociological Review 49: 56-70.

Pfeffer, J and J. Rose
1982 "The Effects of Marriage and Working Wife on Occupational and Wage Attainment." Administrative Science Quarterly 27: 66-80.

Polmore E. and P. E. Hammond
1964 "Interacting Factors in Juvenile Delinquency". American Sociological Review 29: 848-54.

Ragin, C. C., S. E. Mayer and K. A. Drass
1984 "Assessing Discrimination: A Boolean Approach". American Sociological Review 49: 221-34.

Ransford, H. E. and J. Miller
1983 "Race, Sex and Feminist Outlooks". American Sociological Review 48: 46-59.

Rindfuss R. R. and S. P. Morgan
1983 "Marriage, Sex and the First Birth Interval: The Quiet Revolution in Asia" Population and Development Review 9: 253-72.

1984 "The Transition to Motherhood: The Intersection of Structural and Temporal Dimensions", American Sociological Review 49: 359-72.

Robinson, R. V.
1984 "Reproducing Class Relations In Industrial Capitalism". American Sociological Review 49: 182-196.

Rosenfeld, R. A.
1983 "Sex Segregation And Sectors: An Analysis Of Gender Differences In Returns From Employer Changes"." American Sociological Review 48: 637-655.

Ross, C. E., J. Mirowsky and J. Huber
1983 "Dividing Work, Sharing Work and In-between : Marriage Patterns and Depression". American Sociological Review 48: 809-823.

Ryder, Norman
1976 "Some Sociological Suggestions Concerning The Reduction of Fertility in Developing Countries", papers of the East-West Population Institute, No. 37 (Honolulu: East-West Center).

1980 "Components of Temporal Variations in American Fertility" in Robert W. Hiorns (ed.) Demographic Patterns in Developed Societies. Taylor and Francis.

Saris, Willem, Stronkhorst Henk
1984 Causal Modelling in Nonexperimental Research: An Introduction to The LISREL Approach. Sociometric Research Foundation. Amsterdan, The Netheriand.

Seeman, M. and C. S. Anderson
1983 "Alienation and Alcohol: The Role or Work, Mastery and Community in Drinking Behavivor". American Sociological Review 48: 60-77.

Simkus, A.
1984 "Structural Transformation and Social Mobility". American Sociological Review 49: 291-307.

Smith, T. E.
1984 "School Grades and Responsibility For Younger Siblings: An Empirical Study Of the Teaching Function". American Sociological Review 49: 248-60.

Smith, A. Wade
1981 "Racial Tolerence as a Function of Group Position". American Sociological Review 46: 558-72.

Spaeth, J. L.
1985 "Job Power and Earnings". American Sociological Review 50: 603-17.

Sorbom, Dag
1974 "A General Method for Studying Differences In Factor Means And Factor Structure Between Groups", British Journal of Mathematical and Statistical Psychology 27: 229-309.

1981 "Structural Equation Models With Structured Means". in K. G. Joreskog and H. Wold (eds.) System Under Indirect Observation Causality Structure and Prediction. Amsterdan: North-Holland.

Sorbom, D. and Joreskog, K. G.
1981 "The Use of Structural Equation Models In Evaluation Research". Research Report 81-6. University of Uppsala, Department of Statistics.

Southwood, K.
1978 "Substantive Theory and Statistical Interaction: Five Models" American Journal of Sociology 83: 1154-1203.

Sri Lanka, Department of Census and Statistics.
1978 World Fertility Survey, Sri Lanka, 1975, First Report. Colombo, Sri Lanka: Department of Census and Statistics.

Stevens, Gillian
1981 "Social Mobility and Fertility: Two Effects In One". American Sociological Review 46: 573-85.

Stolzenberg, R. M.
1974 "Estimating on Equation With Multipliative and Additive Terms, With An Application to Analysis of Wage Differentials Between Men and Women in 1960", Sociological Methods and Research, 2(3): 313-32.

1980 "The Measurement and Decomposition of Causal Effects in Nonlinear and Nonadditive Models." pp.459-488 in K. F. Schuessler (ed.) Sociological Methodology. San Francisco: Jossey-Base.

Swift, M.
1964 "Men and Women in Malay Society", pp. 268-86 in Women In Asia, ed. Barbara E. Ward, Paris: UNESCO.

Thurow, L.
1967 "The Occupational Distribution of Returns To Education And Experience for Whites and Negroes". Proceedings of American Statistical Association, Social Statistics Section.

Thornberry, T. P.
1982 "Social Correlates of Criminal Involvement: Further Evidence On the Relationship Between Social Status and Criminal Behavior". American Sociological Review 47: 505-18.

Thornton, R.
1981 "Demographic Antecedents Of A Revitalization Movement: Population Change, Population Size and The 1890 Ghost Dance". American Sociological Review 46: 88-96.

Tien, H. Yuan
1970 "Marital Moratorium and Fertility In China" Pouplation Studies 24(3): 307-23.

Tolbert, C. M. II
1982 "Industrial Segmentation and Men's Career Mobility". American Sociological Review 47: 457-77.

Treas, J.
1983 "Trickle Down Or Tansfers ? Postwar Determinants of Family Income Inequality". American Sociological Review 48: 546-59.

Trussel, T.J. and J. Menken
1978 "Early Childbearing and Subsequent Fertility". Family Planning Perspectives 10: 209-22.

United Nations
1983 Relationships Between Fertility and Educaiton: A Comparative Analysis of World Fertility Survey Data For Twenty-Two Developing Countries. Department of International Economic and Social Affairs. New York.

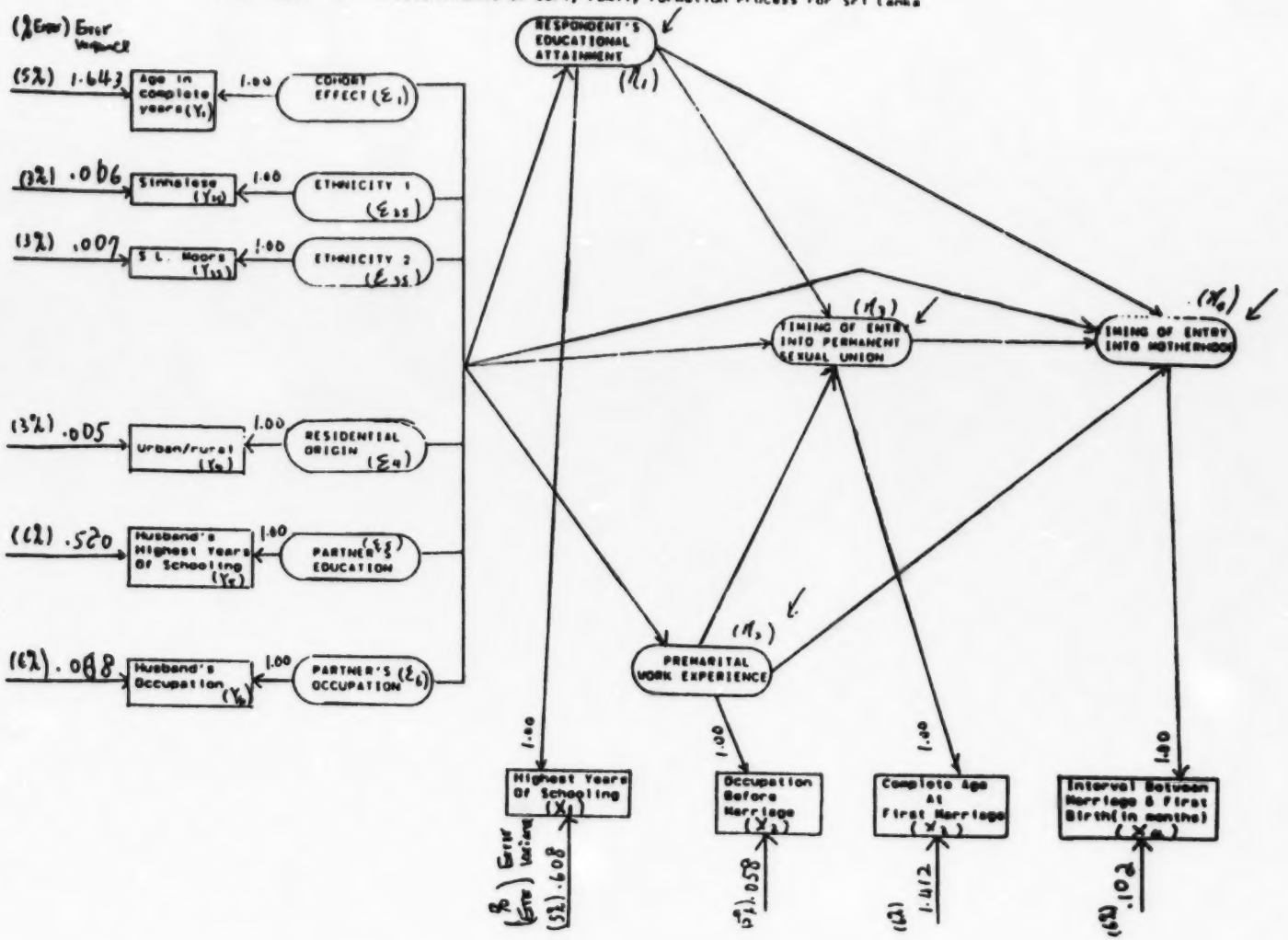
Veevers, J. E.. and Taylor, P. A.
1979 "Voluntary Childlessness: A Review of Issues and Evidence". Marriage and Family Review 2: 3-26.

Winship C. and R. D. Mare
1984 "Regression Models With Ordinal Variables". American Sociological Review 49: 512-525.

Wood, M. and M. Hughes
1983 "The Moral Basis of Moral Reform: Status Discontent Vs. Culture and Socialization as Explanation Of Anti-pronography". American Sociological Review 48: 60-77.

Wright, E. O., C. Costello, D. Hachen and J. Sprague
1982 "The American Class Structure". American Sociological Review 47: 709-26.

APPENDIX


LISREL Model for the Determinants of Early Family Formation Process for Sri Lanka
(Error Variance)
(52) 1.643
Age in complete years (Y1)
1.00
COHORT EFFECT (ξ1)
(32) .006
Sinhalese (Y10)
1.00
ETHNICITY 1 (ξ10)
(32) .007
S.L. Moors (Y11)
1.00
ETHNICITY 2 (ξ11)
(32) .005
Urban/rural (Y9)
1.00
RESIDENTIAL ORIGIN (ξ9)
(62) .520
Husband's Highest Years of Schooling (Y2)
1.00
PARTNER'S EDUCATION (ξ2)
(62) .088
Husband's Occupation (Y6)
1.00
PARTNER'S OCCUPATION (ξ6)
RESPONDENT'S EDUCATIONAL ATTAINMENT
(η1)
(η3)
TIMING OF ENTRY INTO PERMANENT SEXUAL UNION
(η6)
TIMING OF ENTRY INTO MOTHERHOOD
(η5)
PREMARITAL WORK EXPERIENCE
1.00
Highest Years of Schooling (X1)
(δ) Error Variance
(52) .608
1.00
Occupation Before Marriage (X2)
(52) .058
1.00
Complete Age at First Marriage (X3)
(52) 1.412
1.00
Interval Between Marriage & First Birth (in months) (X4)
(52) .102

LISREL Model for The Determinants of Early Family Formation Process For Malaysia.